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Research and Technology Objectives and Plans

NASA
National Aeronautics and Space Administration

SUMMARY

FISCAL YEAR 1980 RESEARCH AND TECHNOLOGY PROGRAM

This Supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, at the price code A10 ($9.25 domestic; $18.50 foreign).

INTRODUCTION

This publication represents the NASA Research and Technology program for FY 1980. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objectives and Plans) used for management review and control of research currently in progress throughout NASA. The *RTOP Summary* is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. We believe also that this publication can help to expedite the technology transfer process.

The *RTOP Summary* is arranged in five sections. The first section contains citations and abstracts of the RTOPs. Following this section are four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number.

The Subject Index is an alphabetical listing of the main subject headings by which the RTOPs have been identified.

The Technical Monitor Index is an alphabetical listing of the names of individuals responsible for the RTOP.

The Responsible NASA Organization Index is an alphabetical listing of the NASA organizations which developed the RTOPs contained in the Journal.

The RTOP Number Index provides a cross-index from the RTOP number assigned by the NASA responsible organization to the corresponding accession number assigned sequentially to the RTOPs in *RTOP Summary*.

As indicated above, responsible technical monitors are listed on the RTOP summaries. Although personal exchanges of a professional nature are encouraged, your consideration is requested in avoiding excessive contact which might be disruptive to ongoing research and development.

Any comments or suggestions you may have to help us evaluate or improve the effectiveness of the *RTOP Summary* would be appreciated. These should be forwarded to:

National Aeronautics and Space Administration
Office of Aeronautics and Space Technology
Washington, D.C. 20546
Attn: William P. Peterson, Director
Resources and Management Systems Division (RM-3)

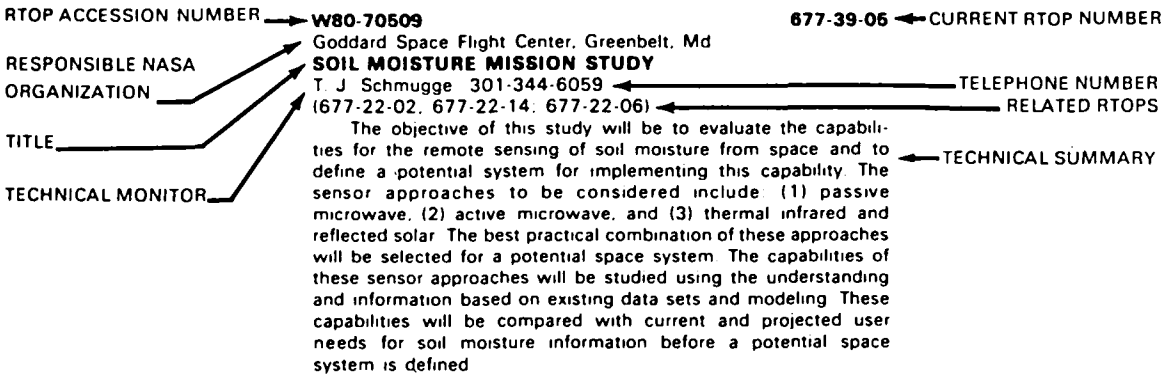
Walter B. Olstad
Acting Associate Administrator for
Aeronautics and Space Technology

TABLE OF CONTENTS

Office of Space and Terrestrial Applications

Office of Space Science

TYPICAL CITATION AND TECHNICAL SUMMARY



RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS

a summary

FISCAL YEAR 1980

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

Aeronautics Research and Technology Base

W80-70001 **505-31-11**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL METHODS AND APPLICATIONS IN FLUID DYNAMICS
V. L. Peterson 415-965-5265

The overall objective is to develop the capability for predicting complete aerodynamic characteristics of given aircraft shapes and designing new configurations aerodynamically optimized for specific missions to a degree that preliminary concepts can be developed, evaluated, and screened with less time, cost, and wind tunnel tests. New mathematical methods, languages, and compilers will be constructed to realize the most effective use of available computer resources. Computer programs will be developed to simulate turbulence and to solve complex fluid dynamics problems for the complete spectrum of flight speeds, from low subsonic, transonic, to hypersonic, and for steady and unsteady, inviscid and viscous flow over two and three dimensional configurations. Fundamental experiments will be performed to verify these codes and to provide the necessary turbulence models. The Reynolds number domain will extend from conventional wind tunnel conditions to full scale flight conditions for present and future aircraft. The timely transfer of advanced computational aerodynamics technology to the aerospace community will be implemented by developing and disseminating computer codes applicable to practical aerodynamics problems. New facilities for numerically simulating aerodynamics problems will be investigated in order to define the design requirements and to assess costs, performance, and reliability.

Fluid Physics Research and Technology

W80-70002 **505-31-13**
Langley Research Center, Hampton, Va.
COMPUTATIONAL AERODYNAMICS
J. C. South, Jr. 804-827-2627

The purpose of this research is to provide the fundamental computational methods required for calculating complete aerodynamic characteristics of complex aircraft shapes and for optimizing aircraft shapes for a given mission. The primary emphasis will be basic research in numerical and analytical methods coupled with large-scale computers. Most computer codes developed in this plan will be of the 'pilot code' class; when a method or code is proven as a useful preliminary tool, further developments of the codes for more complex configurations will be supported by RTOPs which are applications-oriented, such as ACEE and EET. Research includes viscous and inviscid flow methods for all speed ranges, with near-term emphasis on the subsonic-transonic range. The main interest is in large, nonlinear problems; studies include acceleration of iterative methods for large systems of finite-difference equations, mesh generation methods, turbulence modeling, and algorithms suitable for vectorprocessor computers such as STAR and CRAY.

W80-70003 **505-31-21**
Ames Research Center, Moffett Field, Calif.
TURBULENCE AND MODELING
L. Roberts 415-965-5066

The objective is to conduct analytical and experimental investigations into complex turbulent flow fields. Two specific tasks are considered: (1) aerodynamics of turbulent flows interacting with shock waves, highly curved bodies and general three dimensional surfaces, and (2) the interaction of electromagnetic waves and complex turbulent flow fields. In the study of interacting turbulent flow fields, the emphasis is placed on obtaining detailed, accurate experimental data that may be used to mathematically model the turbulence structure together with the generation of efficient prediction methods in which various models may be tested. The electromagnetic wave/turbulence interaction study consists of both theoretical and experimental efforts aimed at predicting the distortions of visible and near infrared radiation, and includes the use of advanced aerodynamic instrumentation on a full scale flight test to observe turbulence at actual flight conditions.

W80-70004 **505-31-23**
Langley Research Center, Hampton, Va.
TURBULENT DRAG AND NOISE REDUCTION
D. M. Bushnell 804-827-4546

The purpose of this research is to significantly improve our ability to predict and control the behavior of turbulent shear flows including boundary layers, free shear layers and recirculating/vortex flows. Theoretical and experimental research is included to reduce turbulent skin friction drag, identify sources of and minimize airframe noise, control stream disturbances in transonic/supersonic/hypersonic tunnels, and improve understanding of physics/structure of turbulent shear flows and turbulence modeling for computation fluid dynamics. Drag reduction research investigates moving/compliant walls, fixed transverse and longitudinal surface waves and large eddy breakup devices, primarily for eventual CTOL transport application. Airframe aerodynamic noise effort determines acoustic characteristics of turbulent flows generated by components such as slats, landing gear, wheel wells and flaps, and investigates noise reduction methods for these flows and their interactions. Free stream turbulence research developes stagnation chamber treatments, laminar flow nozzles and noise shields to improve validity of wind tunnel measurements, especially for data where transition and flow separation are presented. Detailed experiments, using hot wires and LV/Raman systems, provide data for development and validation of turbulence closure models in three-dimensional

boundary layers, three-dimensional free mixing and corner/recirculating/vortex flows.

W80-70005 **505-31-31**
Ames Research Center, Moffett Field, Calif.
AIRFOIL AND WING DEVELOPMENT
L. Roberts 415-965-5066

The objective is to develop analytical, numerical and experimental procedures to assist in the design of advanced airfoils, multielement airfoils and wings. A key element of this program consists of a research project into the unsteady aerodynamics of pitching and plunging airfoils in subsonic and transonic flows. To validate the prediction methods, an oscillating apparatus is to be used for testing 2-D wings in the Ames 11-Foot Transonic Wind Tunnel (TWT) at Reynolds numbers up to 12 x 1,000,000. Research is underway on wind tunnel wall effects in unsteady flow, unsteady flow visualization and unsteady flow field measurements as well as conventional unsteady pressure measurements. Computer codes are under development for predicting steady and unsteady flows about airfoil sections and complete wings. Coordinated experimental studies will provide data required for guidance and verification of the theoretical work directed toward multielement airfoils and wings. Emphasis will be placed on improved turbulence models for high lift configurations, improved multielement drag analysis, and the analysis of three dimensional flows over finite wings with high lift devices. The effects of wing-tip vortex shedding, flap edge vortex shedding, and near wake roll up will be investigated.

W80-70006 **505-31-33**
Langley Research Center, Hampton, Va.
AIRFOIL DEVELOPMENT
R. W. Barnwell 804-827-4514

The Advanced Technology Airfoil Research (ATAR) Program is to provide analytical methods and computer codes coupled with experimental procedures and test facilities for the design and development of airfoils and airfoil systems in both steady and unsteady flows and to employ these tools in the development of advanced-technology single- and multi-element airfoils for all classes of aircraft. The applications include propeller sections and airfoils for fixed- and rotory-wing aircraft and involve the subsonic and transonic speed regimes and laminar and turbulent boundary layers. The program includes the generation of precise theoretical and rapid engineering analysis and optimal-design methods which have been verified through appropriate selected experiments, the development of new and improvement of existing airfoil research facilities to improve the range and validation of two-dimensional data, and the generation and documentation of the aerodynamic behavior of new families of airfoils, airfoil controls and high-lift systems by the use of both theory and experiment in support of U.S. industry and DOD to satisfy specific and special-purpose airfoil needs.

W80-70007 **505-31-41**
Ames Research Center, Moffett Field, Calif.
AERODYNAMIC THEORY/EXPERIMENTAL INTEGRATION
R. H. Petersen 415-965-5859

The objective of this research is to expand the aerodynamic technology base and provide a basic understanding of the aerodynamic flow fields about complete wingbody-tail configurations as well as individual components through the useful angle-of-attack range and from subsonic through supersonic Mach numbers. This is being accomplished in two ways: (1) the development of new theoretical methods; and (2) the integration of theory and experiment to yield a more complete understanding of the aerodynamic phenomena. The primary theoretical methods under development include a transonic wing-body-tail code using the full potential equations and an advanced linear panel code applicable to both subsonic and supersonic flow. In addition, methods will be developed to combine various calculation techniques to predict more complex flows, such as jet induced effects, or to numerically optimize aircraft components. The integration of theory and experiment includes the development of techniques to rapidly compare calculated and measured results and to integrate theoretical and experimental procedures to provide a more complete definition of the aerodynamic characteristics.

W80-70008 **505-31-43**
Langley Research Center, Hampton, Va.
CONFIGURATION AERODYNAMICS
R. T. Whitcomb 804-827-2252

The technical objective is to increase the aerodynamic technology base for the design of wings, wing/bodies and generalized aircraft configurations through the generation and application of an expanded experimental data base and the development and evaluation of improved theoretical and empirical design and analysis methods. A practical means will be developed for improving the aerodynamic performance of high subsonic and supersonic cruise aircraft. The expansion of the experimental data base will be accomplished through parametric wind tunnel tests, guided by theoretical analysis with emphasis on favorable interference of multiple lifting surfaces, interacting vortex flows and vortex lift optimization, supercritical flow, investigation of swept forward wings, and application of variable geometry concepts. Methods of predicting the complete surface aerodynamic load distribution, with emphasis on the critical aerodynamic and structural design conditions involving edge separation induced vortex flows will be developed. Innovative configurations with improved cruise efficiency will be investigated analytically and experimentally. For the most promising of the proposed new configurations both theory and wind tunnel tests will be used to assure that the performance, buffet, loads, stability, and controllability are acceptable over their entire flight envelopes. Further, theory and experiments will be used to investigate advanced high lift systems for loading and takeoff and means for increasing the off-design performance of configurations with high cruise efficiency.

W80-70009 **505-31-44**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AERONAUTICS FLIGHT EXPERIMENTS
T. R. Sisk 805-258-3311

The objective is to provide a continuing research and development effort into the problems associated with the fundamental understanding of fluid and flight mechanics with special emphasis on the relationship to large-scale vehicles operating in a real world environment free of interference effects. These efforts include experimental aerodynamic studies to improve the ability to predict the efficiency of vehicles moving through the atmosphere, and to define the effects of Reynolds number, surface condition, excrescences, and local and freestream flow conditions on lifting surfaces and complete configurations. Also included will be investigations in support of or verification of wind tunnel studies. Experimental research pertaining to laminar and turbulent boundary layer phenomena and on the separation characteristics of turbulent flow over afterbodies will also be conducted as will analytical studies appropriate to support the fluid mechanics disciplines.

W80-70010 **505-31-51**
Ames Research Center, Moffett Field, Calif.
AERODYNAMIC TEST METHODS AND INSTRUMENTATION
L. Roberts 415-965-5066

The general objective of this research is to provide the technology for increased ground based aerodynamic experimental research capability required to improve prediction of performance and flight characteristics of conceptual or new aircraft designs and the exploration of advanced aerodynamic concepts. Tunnel wall constraints, flow quality and means for simulating higher Reynolds number flows will be investigated analytically and experimentally to improve the quality of test results. To improve the state-of-the-art in nonintrusive measurement capability, advanced laser velocimeter and holographic instrumentation systems will be developed to obtain fundamental fluid mechanic measurements such as mean velocities, turbulence intensities and Reynolds stress components. Infrared camera technology will be explored as a means of locating shock waves and regions of separation on wind tunnel models.

W80-70011 **505-31-53**
Langley Research Center, Hampton, Va.
EXPERIMENTAL METHODS AND INSTRUMENTATION
R. A. Kilgore 804-827-3711

The technical objective is to provide the technology for increased ground bases aerodynamic experimental transonic research capability required to improve prediction of performance and flight characteristics of conceptual or new aircraft designs and the exploration of advanced aerodynamic concepts. Inhouse, contract and grant research will be utilized to advance the state-of-the-art with regard to: (1) cryogenic wind tunnel research technology; (2) magnetic suspension and balance application; (3) transonic tunnel wall interference; (4) improved instrumentation techniques; and (5) advanced sensors.

W80-70012 **505-31-54**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT RESEARCH INSTRUMENTATION DEVELOPMENT
J. P. Smith 805-258-3311

The objective of this program will be to investigate and develop new methods of acquiring improved flight research data. The lack of these improved data will seriously impact the quality of future flight research programs. An on-going, intercenter development program with Dryden Flight Research Center serving as lead center will be conducted to achieve the objectives of this project.

W80-70013 **505-31-63**
Langley Research Center, Hampton, Va.
FULL SCALE REYNOLDS NUMBER TEST TECHNOLOGY
L. W. McKinney 804-827-3711

The technical objective is to develop the test technology required to fully exploit the unique capabilities of the new pressurized cryogenic wind tunnels in the performance of research and development studies related to advanced aerodynamics design concepts at full scale Reynolds numbers. This objective will be accomplished utilizing inhouse, contract and grant research to: (1) extend development of cryogenic technology and full scale Reynolds number test techniques to insure maximum utilization of the unique research and development capabilities of the new Langley National Transonic Facility; (2) continue development of technology required for sound engineering of models for the high pressure cryogenic environment including establishment of model criteria; and (3) provide instrumentation and measurement techniques capable of operating over a wide temperature range with emphasis on minimizing measurement error and time required for data collection.

W80-70014 **505-31-70**
Langley Research Center, Hampton, Va.
POST-SPILL LIQUID HYDROGEN BEHAVIOR
R. D. Witcofski 804-827-3838

The objective will be to provide the technology for predicting the behavior and character of relatively large quantities of spilled liquid hydrogen, the vapor which subsequently forms, and any resultant deflagration or detonation. The approach will be to define what is considered to be credible liquid hydrogen spills, and to develop analytical models for adequately describing the several phenomena, with the modeling guided and validated by appropriate experiments. Key issues will be addressed in a logical sequence to establish early the severity of the hazards problems and the range of variables to be included. Phenomena include the vaporization rate of liquid hydrogen when spilled onto various surfaces (e.g., soil, concrete), the time-history character and behavior of the vapor cloud formed as a result of spills, and the deflagration and detonation characteristics of hydrogen-air-cloud mixtures. Both inhouse and contractual efforts will be required.

W80-70015 **505-31-73**
Langley Research Center, Hampton, Va.
HYPERSONIC AIRCRAFT AERODYNAMICS AND FLIGHT DYNAMICS
F. S. Kirkham 804-827-3877

The primary objective of this effort is to provide an aerodynamics technology base for future airbreathing hypersonic aircraft through theoretical analysis and experimental investigations of configuration aerodynamics, stability and control, aerodynamic heating, and propulsion system integration. Areas to be emphasized are those which hold the highest potential for future pay-offs, such as deriving benefits in vehicle performance from mutual interactions of the aircraft and its propulsion system and the development of configurations which minimize areas of interference heating. Many aspects of this program such as the advanced analysis and design techniques are generally applicable to supersonic aircraft and future space transportation systems as well as to hypersonic vehicles. The approach to be used will emphasize the development and application of advanced analytical and experimental methods which are capable of addressing complex flow phenomena such as the propulsion system exhaust. Analysis methods will include such effects as viscous flows, inlet spillage, embedded shocks, and finite rate chemistry. Experimental methods will include provisions for making force measurements in conventional wind tunnels of models with simulated exhaust flows. A systematic conceptual design and evaluation procedure will be implemented with which meaningful trade studies can be made and the conceptual design work will be used to guide future technology development.

W80-70016 **505-31-83**
Langley Research Center, Hampton, Va.
APPLIED MATHEMATICS AND COMPUTER SCIENCE
W. D. Erickson 804-827-2471

This RTOP provides for the conduct of basic research in applied mathematics and computer science. The research is carried out by a combination of inhouse efforts, university research grants, and the continuing operation of the Institute for Computer Applications in Science and Engineering (ICASE) located at the Langley Research Center. The inhouse and grant efforts include research dealing with numerical solutions of differential and algebraic systems, data analysis, computer graphics, symbolic and algebraic manipulation, data base management, programming languages, microprocessor software, and software engineering. The broad research areas pursued in ICASE include the efficient use of vector and parallel computers, numerical analysis, computational research in selected areas of science and engineering of interest to NASA, and computer systems and software.

Propulsion Research and Technology

W80-70017 **505-32-01**
Ames Research Center, Moffett Field, Calif.
NOISE REDUCTION TECHNOLOGY FOR SHORT-HAUL AIRCRAFT
D. H. Hickey 415-965-5036

The work described will provide the technology for the reduction of noise of short-haul aircraft, and will provide, through wind-tunnel measurements, large-scale data on relative velocity effects on noise of modern turbofan and turbojet engines. The FY80 jet noise program includes the reporting of flight effects on the jet noise of a modified viper engine with mechanical supressors and completion of the joint programs with the RAE and ONERA on the development of wind tunnel techniques for noise testing. Work on flight effects on fan noise will continue with the completion of testing and reporting of tests of a JT15D engine with conventional inlet and modified stator, and tests of a JT15D engine with instrumented fan rotor. It is planned to have an advanced inlet for testing with the instrumented rotor. Work on flow visualization and diagnostic techniques for jet noise measurements in the 40- by 80-foot wind tunnel will be continued.

W80-70018 **505-32-02**
Lewis Research Center, Cleveland, Ohio.
PROPULSION SYSTEM NOISE RESEARCH
C. E. Feiler 216-433-6189

The objectives of this RTOP are to provide data and a technology base for reducing aircraft propulsion-generated and

associated noise with minimum weight, performance, and economic penalties, and to develop techniques for accurate prediction of noise levels of operating and future aircraft. The generation and propagation of noise from all engine sources, both internal and external, are addressed. These include the turbomachinery (fan, compressor, turbine), core engine (combustor, internal surfaces) and the jet noise. Acoustic suppression (duct treatment) is a major element of the work. The work is distributed among: basic research that provides knowledge of the fundamental principles and phenomena present in noise generation and propagation; applied research that explores concepts, and provides a data base; and demonstration of technology on full-scale engine systems. In-house activities are balanced by a few contractual programs including university grants. In-house facilities include the engine fan and jet noise facility (W-2) for model fan and jet experiments, several hot and cold flow jet rigs, two outdoor engine stands capable of full-scale engine tests including thrust performance, and a small laboratory flow duct apparatus. Forward velocity experiments are conducted in the 9X15 low speed wind tunnel.

W80-70019 **505-32-03**
Langley Research Center, Hampton, Va.
PROPULSION NOISE RESEARCH
H. H. Hubbard 804-827-3577

The objective of this research is to provide a data and technology base for reducing aircraft propulsion generated noise with minimum weight, performance, and economic penalties; and to develop techniques for accurate prediction of ground noise levels of operating and future aircraft. Both theoretical and experimental noise reduction and control studies are involved and work will be accomplished inhouse and by grants and contracts. Emphasis in the experimental portion of the program is on laboratory and scale model experiments under closely controlled conditions with supplemental acoustic range and flight vehicle studies for validating theoretical methods and concepts. Included are the following specialty areas: precision measurements and calculations of the sound fields inside ducts with airflow, with varying geometry and with and without acoustic liners; optimization methods for design of acoustic liners; forward motion effects on inlet noise; understanding of jet noise generation and propagation through analytical studies and precision measurements; identification and location of sound sources in flow fields; noise generation by viscous flow fields; atmospheric propagation including refraction and scattering; development and validation of procedures for predicting single event flyover noise exposures from general aviation and CTOL aircraft and helicopters; and development of advanced methods of noise measurement and analysis.

W80-70020 **505-32-05**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
BASIC NOISE RESEARCH
Paul F. Massier 213-354-3549

The general objectives are (1) to determine and evaluate the large variety of the fundamental fluid mechanics phenomena that govern the production of noise in jets; (2) to conceive methods of modifying the fluid mechanics that will reduce the noise radiated from jets; (3) to advance the understanding of the mechanisms by which the pressure disturbances generated upstream of a nozzle are reflected and transmitted through the nozzle flow and radiated to the far field as noise; (4) to advance the understanding of the manner in which a flowing air stream surrounding a jet interacts with the jet and changes the radiated noise; (5) to determine the underlying phenomena associated with the shielding of noise by a jet when greater noise production occurs in a nearby source such as noisier jet; and (6) to determine and evaluate the fluid mechanics phenomena that occur with respect to noise production when two nearby jets merge. Experiments of supersonic, subsonic and coannular jets are performed at temperatures between 70 F and about 2000 F. These studies are conducted in an anechoic chamber. Simulated flight conditions are established by supplying coannular flow around the primary nozzle. Velocity distributions in the jets are determined from measurements of pressures and temperatures obtained with probes. Shadowgraph and Schlieren photographs are taken for visualization analysis. High-speed (7000 frames/sec.) Schlieren movies are also obtained. As an example, the high-speed Schlieren movies are synchronized with signals received by microphone and hot-wire sensors to determine the significance of the pairing process of large-scale turbulent structures on the generation of noise. A series of microphones is placed in the near-field outside the jet so that the pressure signals generated can be evaluated when this merging process occurs. Nitrogen, helium, argon and other gases of different molecular weights are expanded through coannular nozzles to evaluate the effect of density on inverted velocity profile jets.

W80-70021 **505-32-12**
Lewis Research Center, Cleveland, Ohio.
INLET AND NOZZLE RESEARCH
D. N. Bowditch 216-433-6123

Improved analytical and experimental design methodology for inlets and nozzles will be generated to achieve high performance with increased propulsion system stability. Computer analysis programs for predicting internal flows will be synthesized in-house and by contracts and grants. These programs will make it possible to analyze viscous and inviscid flows in two and three dimensions. Basic benchmark testing will be done to define detailed flow phenomena to guide and verify the analysis. Inlet and nozzle hardware will be used to conduct exploratory research in areas that are not presently amenable to analysis.

W80-70022 **505-32-13**
Langley Research Center, Hampton, Va.
PROPULSION SYSTEM INTEGRATION
W. P. Henderson 804-827-2676

Fundamental studies will be conducted to develop an improved understanding of the flow phenomena associated with the integration of the propulsion system into advanced aircraft concepts. Through this research propulsion system integration concepts will be studied that are designed to exploit favorable interference effects which may enhance the wing lift, performance efficiency, reduce drag or permit thrust reversing of the exhaust system to improve performance of the aircraft. For the exhaust nozzle, investigations will be made to determine means of improving the internal and external performance of both uninstalled and installed nozzles and to explore the integration procedures for incorporating the exhaust system into the fuselage, wing or pods. General experimental and theoretical research studies will be conducted to improve the understanding of the flow phenomena associated with nozzle/boattail/jet and jet/wing/airframe empennage interference. Advanced analytical methods capable of predicting the propulsion system integration effects will be developed. These methods will vary from the simpler, faster patched methods to the more complex Navier-Stokes solutions. Experimental research on axi- and nonaxisymmetric nozzles will be conducted for correlation with analytical results and design procedures will be developed from this information.

W80-70023 **505-32-22**
Lewis Research Center, Cleveland, Ohio.
FAN, COMPRESSOR, AND TURBINE RESEARCH
M. J. Hartmann 216-433-6906

Approaches to improve efficiency, operating range, distortion tolerance, durability, and reliability; and to reduce weight, volume, and cost of the wide variety of fans and compressors required for advanced propulsion systems will be investigated. The objective of the turbine program is the attainment of increased life and improved turbine cooling and aerodynamic design methods for both axial and radial flow turbines. Increased emphasis is placed on verifying and demonstrating the capability of internal flow analysis codes for improving the accuracy and reliability of compressor and turbine design systems. Accuracy and reliability of design systems and performance prediction methods are improved through more accurate modeling of stage internal flows. The advanced analytical methods will result in large cost savings by reducing both the time required and the risk involved in incorporating advanced components into future engine development programs. Flutter characteristics of selected current and advanced fan and compressor blading systems will be evaluated

in the fullscale engine enivronment. Advanced analytical techniques for predicting flutter will be generated and evaluated. The work is conducted through inhouse, contract, and university grant efforts.

W80-70024 **505-32-32**
Lewis Research Center, Cleveland, Ohio.
COMBUSTION AND AUGMENTATION SYSTEMS RESEARCH
D. A. Petrash 216-294-6860
(505-03-22; 505-04-32; 505-04-52)

This RTOP covers basic and applied combustion research as well as combustor technology activities. Basic combustion research is devoted to the study of various fundamental aspects of combustion phenomena. These activities include experimental studies of flame speed, autoignition, and flashback as well as numerical modeling of combustion phenomena. Applied combustion research activities are conducted to learn more about the flow dynamics of combustion systems and the various combustor components such as diffusers. Specific emphasis is being given to internal flow and mixing within combustors. Combustor technology program efforts are divided between large annular straight-through and small, annular reverse flow combustors. Activities include evaluation of various fuel injection concepts at pressures up to 25 atmospheres, preliminary investigation of ceramic-metal liner materials as well as studies of various advanced combustor concepts. The purpose of these combustor concept studies is to evaluate the potential of these new approaches to achieve high performance, low emissions and good durability at conditions typical of advanced commercial and military gas turbine engines. Similar activities are conducted for the small gas turbine engine combustors. Specific problem areas include fuel injection research liner cooling and mathematical modeling for combustor performance prediction.

W80-70025 **505-32-42**
Lewis Research Center, Cleveland, Ohio.
POWER TRANSFER RESEARCH
W. J. Anderson 216-433-4000

The objectives of this work are to advance the state of the art in tribological science and in the technology of mechanical components such as bearings, shaft seals, gas path seals, gears, shafts, lubricants and lubrication systems. Goals are to achieve improved component performance, life, reliability and efficiency in the high temperature, high speed and high pressure environments of turbojet and turbo-propeller engines and mechanical power transmission systems. Emphasis will be given to an interdisciplinary approach to tribological science to create far term opportunities as well as to satisfy near term goals for both improved component and system performance. Analytical techniques for balancing, determining and controlling the dynamic behavior of rotating assemblies (shafts, bearings, dampers, seals and aerodynamic components) will be developed and corroborated experimentally to provide better design tools for high speed rotating machinery.

W80-70026 **505-32-52**
Lewis Research Center, Cleveland, Ohio.
COMPUTATIONAL FLUID MECHANICS FOR TURBOMACHINERY
M. J. Hartmann 216-433-6906

The objective of the computational fluid mechanics program for turbomachinery is to develop the analytical and computational analyses to simulate and predict the steady and unsteady flow conditions in advanced fans and compressors, and cooled turbines. These flow analysis methods are developed into practical models and codes for use on computers available at Lewis, at other NASA centers, and throughout industry, as well as the advanced computers available in the near future. Specific objectives include the following: (1) originate, develop, and improve analyses for the prediction of both aerodynamic and aeroelastic flow effects in advanced fans, compressors, and cooled turbines; (2) develop new analytical and numerical techniques and models for incorporation into advanced codes; (3) build analysis tools into a practical, highly useful analysis/design system through improvements and integration; (4) incorporate extensive graphics into the analysis codes to maximize understanding of the results; (5) develop methodology to enable the user to more rapidly cover the range of all the parameters in the analysis space; (6) to investigate the use of advanced computers for some of the longer running codes; (7) to conduct basic experiments to obtain data for the modeling of flows and for code verification; and (8) to verify models and codes against this experimental data. The work is conducted through in-house, contract, and university grant efforts.

W80-70027 **505-32-64**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
PROPULSION INTEGRATED CONTROL TECHNOLOGY
H. P. Washington 805-258-3311

This effort will conduct studies to improve the understanding and prediction of propulsion system dynamic behavior when integrated with other aircraft systems. Such integration should result in improved performance, increased safety, and reduced life cycle costs. The FY-80 effort will include a brief study of propulsion system-airframe control interactions during F-14 high angle of attack flights, and studies of variable throttle energy management trajectory optimization routines for the F-15. Out year efforts will add contractor studies extending the energy management work.

W80-70028 **505-32-72**
Lewis Research Center, Cleveland, Ohio.
FUELS RESEARCH
J. Grobman 216-433-6229

The potential properties of future aviation turbine fuels derived from nonpetroleum sources such as oil-shale and coal will be determined by synthesis and characterization techniques. The effects of these fuels, as well as petroleum based fuels synthesized to broader specifications than currently required, on the performance and durability jet engine components and materials will be determined. Sufficient quantities of these fuels must be procured and/or simulated by blending of petroleum based fuels and will be used to conduct research tests required to evolve the technology that may be needed to use these fuels in current and future jet aircraft engines. A joint program has been developed with the AFAPL and Lewis to implement an overall integrated effort to best utilize the technical capabilities of the AFAPL and Lewis to conduct the various activities necessary in conducting this program. Cooperative efforts on contract funding and management, and in-house test activities are currently underway and will be used throughout the planned life of this program. Overall coordination with other government agencies, such as the USN, DOE, EPA, and with industry will also be maintained in order to provide proper direction and scope to the program as it develops and proceeds.

W80-70029 **505-32-82**
Lewis Research Center, Cleveland, Ohio.
PROPULSION INSTRUMENTATION RESEARCH
N. C. Wenger 216-433-6646

Present efforts in propulsion research are often limited by the inability to make rapid and precise measurements of the parameters of interest. Rapid advances in propulsion technology have in many cases pushed conventional instrumentation techniques to their limits. Further work on improving conventional instrumentation and measurement techniques will probably result in only incremental improvements. The objective is to expand the instrumentation technology base and to explore new concepts that have the potential for significantly advancing present measurement capabilities. Particular emphasis will be placed in critical areas that have been identified as serious impediments to turbine engine and component testing. They are: (1) combustor gas temperature measurements, turbine blade and vane temperature measurements, and heat flux measurements; (2) dynamic and static strain measurements at high temperatures; and (3) gas flow measurements including flow visualization. New and improved measurement concepts and techniques in each of these areas will be explored with each study culminating in a demonstration or proof test of prototype instrument or system.

W80-70030 **505-32-92**
Lewis Research Center, Cleveland, Ohio.
ADVANCED ENGINE SYSTEM CONCEPTS
R. J. Weber 216-433-4000

Studies will be performed of engine cycles, complete propulsion systems, and integrated engine/airframe combinations applied to representative airplane missions. The object of the studies is to determine desirable engine component and system design characteristics for future aircraft and to identify technology deficiencies and profitable areas for research. The studies will explore the opportunities for satisfying environmental and natural resources constraints and their related impact on propulsion system selection and aircraft performance. Supporting efforts will be included to develop new or improved techniques for estimating the cycle performance, weight, and other characteristics of advanced engine concepts.

W80-70031 **505-32-93**
Langley Research Center, Hampton, Va.
HYPERSONIC PROPULSION RESEARCH
R. A. Jones 804-827-3772

Program is aimed at the development of concepts for airframe-integrated, airbreathing propulsion systems to operate at speeds from Mach 3 to 10. Theoretical and experimental studies are conducted in fuel injection, subsonic and supersonic combustion, and 3-D turbulent reacting flows in ducts of complex geometry having lateral pressure gradients in order to advance prediction and design techniques. Component investigations are conducted in house with Langley facilities on inlets, which are applicable to several types of engines, and combustor and nozzle designs for modular scramjet engines. Performance and design optimization tests are performed with complete boiler-plate component integration models at Mach 7 and Mach 4 conditions in Langley propulsion facilities. The inhouse program is augmented in several areas by R & D grants and contracts. Design studies are conducted both inhouse and under contract on flight-weight, fuel-cooled engine structures and systems. This program is focused on providing the technology for lightweight, fixed geometry, airframe-integrated scramjet engine modules using a dual mode of H2 fuel injection to control mixing and combustion for a wide range of flight speeds. This technology will also provide efficient propulsion for either cruise aircraft, accelerating and maneuvering aircraft, or with hydrocarbon fuel, high-speed highly maneuverable missiles.

Materials and Structures Research and Technology

W80-70032 **505-33-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED PROPULSION MATERIALS - HOT SECTION
H. B. Probst 216-433-4000

The objective is to provide improved materials (metallic and nonmetallic) and processes for use in advanced air-breathing propulsion systems, particularly for aeronautical applications. Materials are sought that offer improvements not only in technical performance but also in economy in terms of total life cycle costs. The classes of materials being investigated include oxide dispersion strengthened alloys, fiber reinforced superalloys, powder metallurgy superalloys, protective coatings, and ceramics. Basic research, both in-house and by university grants, relevant to the high temperature behavior of engine materials is conducted. Results of this basic effort then supply guidance for the more applications oriented program conducted in-house and by industrial contract. Material improvements are judged by mechanical and physical properties as well as quantitative evaluations of microstructural features and performance in simulated-engine environments. Ultimately, highly promising materials and processes that result from this program become candidates for the MATE program to accomplish scale-up and full scale engine testing. Emphasis is on advanced materials for aircraft gas turbine blades, vanes, disks and seals. Specific phenomena encountered in the gas turbine are also studied, e.g., oxidation, hot corrosion, creep and fatigue. A plan to address the problem of shortages of strategic materials, particularly cobalt, will be developed after consultation with appropriate industry and government personnel.

W80-70033 **505-33-21**
Ames Research Center, Moffett Field, Calif.
FATIGUE DAMAGE AND ENVIRONMENTAL EFFECTS IN METALS & COMPOSITES
H. G. Nelson 415-965-6137

The fatigue and fracture behavior of metallic and composite aerospace structure materials will be studied in a continuing effort to improve life prediction procedures. In metallic systems the influence of aggressive environments on the elastic-plastic fracture behavior of low and medium strength alloys will be studied under both static and fatigue loading. A knowledge of the dislocation-environment interaction and its associated influence on deformation and plastic zone formation is anticipated to improve the life predictive capability. The kinetics of heterogeneous surface reactions will continue to be studied. Emphasis will be placed on the H2S/Fe system which will be compared to the H2/Fe system in an effort to better understand the kinetic influences of the aggressive environments. Work on composite systems will continue in an attempt to develop accelerated testing methodology using the techniques of time-temperature superposition. Graphite/epoxy is being studied using lamina behavior to interpret laminate behavior; however, the methodology will be sufficiently general to apply to other composite systems. The equivalences between time and temperature and moisture and temperature developed previously will be applied to predict time dependent property degradation under static, dynamic (moderate to high strain rates), and fatigue loading. Additionally, emphasis will be given to the development of physical interpretations and mechanisms for the observed relationships.

W80-70034 **505-33-22**
Lewis Research Center, Cleveland, Ohio.
FATIGUE, LIFE PREDICTION METHODS, AND FRACTURE CONTROL
M. H. Hirschberg 216-433-4000

The major objective is to obtain a better understanding of the fatigue and fracture behavior of materials, and to develop and verify methods for predicting the life of aerospace structures and components of propulsion systems when subjected to complex time dependent patterns of temperatures and cyclic loads. As part of this objective, laboratory tests methods will be established permitting the evaluation of materials for their load carrying capacity under anticipated operating conditions.

W80-70035 **505-33-31**
Ames Research Center, Moffett Field, Calif.
FIRE RESISTANT MATERIALS
A. H. Heimbuch 415-965-6274

Nonmetallic materials research will be performed to provide polymeric compounds with improved service properties and fire safety for both domestic and military aircraft. Polymer types with potential cost benefit to the development of lightweight aircraft structures will be investigated. Synthesis, chemical modifications, and molecular characterization of high char yield polymers will be done to provide candidate systems from which selctions can be made for resin matrix binders, film formers, adhesives, foams, transparencies and modified carbon fibers. Criterial for selection will include reduced flammability, smoke and toxic gas emissions, fire impact stability and controlled electrical properties. The polymer microstructure, solid state physics and chemistry, environmental performance, and combustion characteristics with the attending toxicological effects as well as thermomechanical properties will be determined on new and advanced state-of-the-art polymers and related to projected applications. The data derived from these studies will serve as a base for analytical studies to predict fire endurance, toxic threat levels, carbon fiber release, and mechanical and environmental performance. Candidate polymers and processes will be provided for evaluation as prototype, subsystem components for testing, with particular and immediate attention being given to resin matrices for carbon fiber composite structures. In addition, quantum chemistry calculations will be applied to large polymers

and graphitic structures to determine such properties as photodissociative stability and conductivity.

W80-70036 **505-33-32**
Lewis Research Center, Cleveland, Ohio.
COMPOSITES FOR PROPULSION COMPONENTS
T. T. Serafini 216-433-6179

The overall objective of this research is to develop polymer matrix and metal matrix composite materials with improved properties and processing characteristics for use in fabricating various aeronautical propulsion structural components. Recent cost-benefit studies show that the use of fiber reinforced composites in turbofan engines can provide significantly improved performance resulting in reduced fuel consumption and operating costs. Composites being considered include resin matrices reinforced with boron, Kevlar, glass fiber, and graphite as well as aluminum matrices reinforced with boron and aluminum oxide fibers. In the area of polymer matrix composites, emphasis is placed on developing processable high temperature resins, low cost fabrication methods and quality assurance procedures, as well as materials specifications for polyimide and epoxy matrix composites. Studies will also be conducted to develop materials and processing technology for carbon/carbon composites. In the metal matrix area, emphasis is placed on the development of improved properties such as impact resistance and on correlation of pretest quality assurance data with mechanical properties. Low cost fabrication processing for compressor components, such as vanes and blades will also be studied.

W80-70037 **505-33-33**
Langley Research Center, Hampton, Va.
STRUCTURAL COMPOSITES AND ADHESIVES
N. J. Johnston 804-827-3041

The objective is to develop new or improved lightweight polymeric composites and metals that have longer lifetimes, greater reliability and improved structural efficiency in aeronautical structures. Research will be aimed at improvement of structural resins and adhesives through systematic variation in polymer molecular structure and at development of new or improved joining and fabrication methods for both metals and composites. Research will also be directed at repair technology of composites including development of appropriate repair procedures and evaluation of their effectiveness and the development of quantitative NDE methods. Environmental degradation studies on composites and structural alloys will be made. The effect of moisture on adhesively bonded composite joints and the effects of impact loading by low mass-high velocity foreign objects on composites will be studied. Diffusion processes will be studied to identify adsorbed and desorbed species on composite surfaces, to relate service environments such as temperature and stress to corrosion behavior in alloys and to develop treatments which will substantially improve corrosion resistance. These programs will help to identify new or advanced materials and processes for aeronautical structural applications and will provide important data on the behavior, capabilities and limitation of such materials.

W80-70038 **505-33-43**
Langley Research Center, Hampton, Va.
ADVANCED AIRCRAFT STRUCTURES
E. E. Mathauser 804-827-2036

The objective is to develop the technology required for obtaining improved efficiency and reduced costs in aircraft structures by the application of advanced composite materials and composite design concepts to commercial aircraft. Research and development are being carried out to establish a technology base of advanced analytical methods for predicting the service life, strength, stiffness, and stability of composite laminates, stiffened cover panels and shear webs. Included are studies to develop fundamental understanding of procedures for quality control of graphite/epoxy composites, environmental effects, accelerated test and analysis methods for prediction long term performance, effects of flaws and damage, and to identify failure modes and failure strain levels. An adequate test data base is being established for substantiation. Confidence is being built in the use of composite aircraft components through longtime flight service programs on both commercial and military transport aircraft. Outdoor environmental degradation of both materials coupons and structural components subjected to static and fatigue loads is being studied over ten-year exposure periods.

W80-70039 **505-33-53**
Langley Research Center, Hampton, Va.
LOADS, AEROELASTICITY, AND STRUCTURAL DYNAMICS
W. H. Reed, III 804-827-2265

The objective is to develop and validate improved methods for the analytical determination of loads, structural response, and structural stability of aerospace systems considering the dynamic and aeroelastic characteristics of the systems and structural interactions with flight control subsystems, and to use these methods in the development and evaluation of techniques for eliminating or minimizing flutter, buffet, noise, and other undesirable response phenomena, and for the enhancement of performance, ride quality, crash safety, and service life. Research will be conducted to provide more accurate unsteady aerodynamic theories, particularly in the transonic range. Advanced aeroelastic analysis methods will be evaluated and validated by both wind tunnel tests and flight tests using the DAST concept (drones for aerodynamic and structural testing). Emphasis will be on measurements of transonic aerodynamic loads, and flight validation of active control systems for load alleviation and flutter suppression. Basic wind tunnel flutter studies will be used to gain a better understanding of the flutter characteristics of advanced aerodynamic configurations. Analysis/synthesis methods will be developed for use in design support of future aircraft with advanced features such as active controls and aeroelastically-tailored wings and empennage. Improved methods for the analytical determination of structural response to noise will be developed, and these methods will be used in the development and evaluation of techniques for minimizing noise transmission for the enhancement of ride quality. Advanced analysis and synthesis capability for predicting and improving transport aircraft crashworthiness and occupant survivability will be developed.

W80-70040 **505-33-54**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT LOADS AND AEROELASTICITY
A. L. Carter 805-258-3311

This RTOP has three primary purposes: (1) to study unsteady aerodynamic loads and flutter suppression at transonic speeds using an RPRV aircraft; (2) to evaluate the state of the art in prediction techniques of aerothermoelasticity, dynamic response, and structural mode control of the B-1 aircraft; and (3) to study airload measurement techniques on large flexible aircraft.

W80-70041 **505-33-63**
Langley Research Center, Hampton, Va.
AERONAUTICAL STRUCTURAL DESIGN METHODS
M. M. Mikulas, Jr. 804-827-2551

The objective is to provide analysis and synthesis capability for multidisciplinary evaluation and design of control configured structurally and aerodynamically advanced aerospace vehicles, and to exploit advances in computer-aided design hardware and methodology. Design methods and guidelines for the application of advanced composite structures to conventional aircraft will be provided. Integrated multidisciplinary analysis and synthesis methodology, with emphasis on applications of advanced technologies including composite structures, configuration aerodynamics, and active controls will be developed. Microprocessor and minicomputer hardware configurations to improve the efficiency for structural calculations will be defined and demonstrated. An understanding of the mechanics of compression failures in flawed composite structures, and appropriate experimentally verified failure prediction techniques will be provided.

W80-70042 **505-33-73**
Langley Research Center, Hampton, Va.
HIGH TEMPERATURE AERONAUTICAL STRUCTURES
S. C. Dixon 804-827-3423

The objectives are to develop structural concepts for future hypersonic aircraft, verify promising concepts by fabrication and

tests of realistic structures, and to devise analysis and design methods applicable to such concepts. Research and development is being carried out to establish a technology base from which the structures and thermal control systems for hypersonic vehicles can be designed. Included in the program are fabrication, experimental and analytical efforts on both airframe and supersonic combustion ramjet (scramjet) structural concepts which will withstand the rigors of extended and repeated use in a hypersonic environment. Research data obtained from both laboratory and wind tunnel experiments will serve to verify analysis and design methods, identifying promising concepts, and provide guidance for future research efforts. The effort is focused primarily on convectively cooled concepts. An actively-cooled panel program has been underway for several years. Testing of three panel concepts and documentation of results should be complete by the end of FY-1980. Design studies of scramjet structural concepts are nearing completion, and development and verification of fabrication techniques of various components constitute the major effort under this RTOP.

W80-70043 **505-33-82**
Lewis Research Center, Cleveland, Ohio.
ENGINE STRUCTURES AND DYNAMICS
R. H. Johns 216-433-4000

The general objective of this program is to develop the technology necessary for the application of advanced materials and design concepts to engine structures and to develop aero-thermomechanical structural analysis and design methodology for advanced engines as complex interacting dynamic systems. Included within the general objective is the definition and concept development of the most promising applications of composites in advanced engines and the development of suitable nondestructive evaluation techniques for use with composites. Design and analysis methods will be developed to provide reliable, lightweight engine structures including hot section components. Analytical and experimental programs related to advanced composite components and their unique strength, stiffness, and weight characteristics to achieve improved engine structural durability and efficient, cost effective operational performance will be continued. Engine system structural models will be developed to provide analytical capability which includes component-to-component interactions, distortions, and displacements due to transient and steady state thermal and mechanical loads. In this way, the designer will be provided with a means to optimize component as well as overall engine design for maximum performance at minimum weight and cost.

Avionics and Controls Research and Technology

W80-70044 **505-34-11**
Ames Research Center, Moffett Field, Calif.
NAVIGATION AND GUIDANCE: SHORT RANGE OPERATIONS
B. Y. Creer 415-965-5450

The objective of this research is to apply and, when necessary, extend modern guidance and navigation theory to optimize rotorcraft, VTOL and STOL aircraft operations within their respective air traffic control environments. Research toward this objective involves two related tasks. The first is to develop methodology and on-board computer algorithms for efficiently synthesizing time-constrained or 4D trajectories that minimize fuel use, direct operating costs and noise. In order to fly the aircraft accurately along these trajectories, techniques from optimal control and estimation theory will be applied to synthesize automatic control laws that correct guidance errors due to errors in modeling, navigation and knowledge of wind and temperature profiles. The various elements of the design will be implemented on an available experimental avionics system and evaluated in piloted simulations and flight tests of representative rotorcraft VTOL and STOL vehicles. The purpose of the second task is to investigate, jointly with the FAA, ATC concepts for effectively integrating the rotorcraft, VTOL and STOL aircraft in the various ATC environments where these vehicles are operated. The goals are to minimize the impact of ATC on the operating costs of these vehicles and to avoid undesirable interactions between CTOL and rotorcraft traffic. Concepts to be investigated in this task include time controlled (4D) guidance and Cockpit Display of Traffic Information (CDTI). The Ames Air Traffic Control Simulation Facility, along with several piloted simulators, will be used to evaluate such concepts.

W80-70045 **505-34-13**
Langley Research Center, Hampton, Va.
NAVIGATION AND GUIDANCE: GENERIC
W. E. Howell 804-827-3551

Development of advanced systems such as NAVSTAR/GPS, coupled with the the rapid advances in electronics and r.f. technology can have tremendous impact on future aircraft and ATC operations. Work done under this RTOP will, in conjunction with FAA and DOD, identify potential candidate concepts for such future systems, develop the technology required for, and perform, proof of concept experiments to develop the data base required for future aircraft and ATC system planning. The technology will also be developed for special applications such as radars for weather and turbulence detection. Studies will be performed to define user class requirements for GPS equipment, and to develop low cost technology for implementation of L band spread spectrum user equipment. Experiments will be performed to validate user class capabilities, and to develop dual fail operational redundancy techniques which will be required in future systems. Digital data link technology will be extended to use with the GPS systems, and combined experiments run in conjunction with FAA.

W80-70046 **505-34-23**
Langley Research Center, Hampton, Va.
COCKPIT AVIONICS: GENERIC
J. J. Hatfield 804-827-3551

Development of advanced cockpit avionics technology (such as electronic display generators and media, input/output techniques, and systems integration techniques), coupled with advances in human factors research, can greatly improve the flight deck of advanced jet transport aircraft, cockpits of general aviation aircraft, and crew stations of other types of aircraft. This technology has the potential to reduce clutter and associated workload, and to improve performance, safety, and flexibility while reducing avionics life cycle cost. Work done under this RTOP will develop cockpit requirements for future civil missions, identify candidate concepts for future cockpit systems, develop the technology for implementation of these concepts, and perform proof of concept experiments using hot bench, simulator, and flight testing. Technology developments will be focused on electronic display media such as the CRT, electroluminescent, and liquid crystal panels; on microprocessor display generation, multifunction switching, and touch panel I/O techniques; and on subsystem/system integration techniques. Experimental testing will be performed in the early phases of the program on laboratory and engineering models. Testing will then progress to prototypes and subsystems testing and culminate in the testing, validation, and demonstration of an integrated cockpit system.

W80-70047 **505-34-31**
Ames Research Center, Moffett Field, Calif.
AIRCRAFT CONTROLS: RELIABILITY & ENHANCEMENT
J. A. Franklin 415-965-5009

Advanced control technology will be explored and developed to enhance the reliability of future aircraft flight control systems. This will include in-house study activities and university grants, oriented towards a unified methodology for the analysis and design of redundancy management and which will be implemented using digital techniques. In-house activities will establish the potential of new concepts for redundancy, identify the sensor/controller/software combinations pertinent to various regions of the V/STOL flight envelope, and determine the control logic for transition between control modes from normal operation to failure conditions. University grants will be awarded to support promising research in the field and to keep NASA abreast of

new advances in control theory pertinent to analysis and synthesis of redundant flight control systems.

W80-70048 **505-34-32**
Lewis Research Center, Cleveland, Ohio.
AIRCRAFT CONTROLS: PROPULSION CONTROL ELECTRONICS
D. I. Drain 216-433-6480

The objective is to develop a technology base for designing highly reliable digital electronic controllers needed for future aircraft turbine engine power plants. Present engine use hydromechanical controllers which exhibit extremely high reliability while operating in a severe environment on the side of the engine. Electronic controllers, needed for the control complexities of future engines, must approach present reliability levels for acceptance into service. The approach will be to employ the latest very-large-scale-integrated (VLSI) circuitry technologies in multiple processor fault tolerant architectures. This approach will need not only hardware developments, but also software technologies for accomplishing a fault tolerant controller. The reliance upon a computer-based software control will require studies intended to develop techniques for insuring the integrity and reliability of needed high technology software. Efforts will also be expended in cooperation with DOD to develop VLSI circuit components to meet the severe engine environment.

W80-70049 **505-34-33**
Langley Research Center, Hampton, Va.
AIRCRAFT CONTROLS: THEORIES AND TECHNIQUES
J. R. Elliott 804-827-4681

The objective of this effort is to develop advanced control theory, procedures, and computer programs for advancing the application of active control functions in aircraft. The approach to be taken is: (1) to conduct studies leading to validation of procedures for mathematical modeling and analysis techniques of flexible aircraft with active controls; (2) to develop and demonstrate computer programs which will provide an optimized control system design; (3) to develop advanced guidance and control system techniques which are practical and consistant with available onboard aircraft instrumentation; (4) to develop aircraft parameter estimation algorithms with improved accuracy and computational efficiency; (5) to develop and validate advanced theoretical concepts for control of aircraft and their trajectories; and (6) to conduct research leading to a scientific/engineering data management system for use in computer-aided design studies of active control aircraft.

W80-70050 **505-34-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AIRCRAFT CONTROLS: FLIGHT RESEARCH
C. R. Jarvis 805-258-3311

This activity will study and develop cost effective methods for implementing advanced, reliable flight control systems that will permit greater operational capability and increased performance of future aircraft. Flight test evaluations of new concepts will be conducted to verify design methods and validate performance in the actual flight environment. Initial emphasis will be toward developing, analytical redundancy management algorithms for sensor fault detection using software techniques to minimize hardware requirements in redundant fly-by-wire system applications. The concept will be flight tested using the F-8 DFBW research aircraft. These algorithms will allow fewer sensors to be used in providing prime data and will provide the capability of analytically computing data that can be used to replace actual hardware sensor outputs should they fail in a redundant set. Investigations of prospective system architectural concepts taking advantage of these algorithms will also be carried out - leading to possible flight test applications. The application of new electronics technology such as fiber optics data transmission and distributed processing to advanced flight control systems will also be investigated. Advanced control law developments by LaRC will be evaluated for flight test experiment candidates using the F-8 DFBW flight test facility.

W80-70051 **505-34-37**
Lyndon B. Johnson Space Center, Houston, Tex.
AIRCRAFT CONTROLS: ELECTROMECHANICAL ACTUATOR TECHNOLOGY
J. T. Edge 713-483-2392
(505-07-33)

The concept of electromechanical flight control actuation is rapidly gaining acceptance as an eventual replacement for hydraulic systems. The objective of this research is to extend the technology development which has been ongoing at the L. B. Johnson Space Center to aircraft application. It is intended to demostrate the techological readiness of electromechanical flight control through a laboratory evaluation and demonstration of a candidate actuation system. Initial phases of the research will establish and classify present and projected actuation requirements in terms of performance, redundancy, and other significant design drivers. Follow-on phases will include the design, fabrication, and evaluation on a single channel system for a typical demanding aircraft flight control application. Finally, a complete redundant surface actuator will be fabricated and evaluated in the laboratory over the complete performance range.

W80-70052 **505-34-43**
Langley Research Center, Hampton, Va.
INTEGRATION AND INTERFACING TECHNOLOGY
Billy L. Dove 804-827-3681
(512-53-13)

The aircraft of the 1990-2000 era will be more efficient and economic because of technology advances of the present and near future. The objective of this effort is to contribute to those advances by developing the technology and assessment methods for the effective application of integrated avionics and controls designs. The approach is to develop the methodology for integrating avionic and control functions; develop models for reliability, safety and performance assessment; identify candidate system architectural concepts; and identify and develop applicable system implementation technology.

W80-70053 **505-34-47**
Lyndon B. Johnson Space Center, Houston, Tex.
INTEGRATION AND INTERFACING TECHNOLOGY: FIBER OPTIC SYSTEM DEVICES
E. A. Dalke 713-483-2851

Inherent bandpass capacity of fiber optic communications makes feasible the usage a single fiber strand to transfer multiple channels of information simultaneously. When applied to aerospace vehicles, the results are replacement of large, heavy, wire cable bundles with significantly fewer and lighter fiber optic bundles. The development of an integrated monolithic optical multiplexer/demultiplexer, and associated electrical interface transformation makes wire bundle elimination possible. The development objectives are to provide a stand-alone optical multiplexer/demultiplexer component capable of bi-directional, full duplex operation with a channel capacity of 16. The component should provide a direct plug-in compatibility which supports both digital and analog interfaces for inter-LRU communications or control. The approach is to build upon a basic 8-channel mux/demux device now in research and development, and to develop necessary system interfaces, inter-connects and terminations, and desired architectural configurations. The development will demonstrate the feasibility of product producibility and provide a test configuration to demonstrate integrated aerospace systems applications.

Human Factors Research and Technology

W80-70054 **505-35-21**
Ames Research Center, Moffett Field, Calif.
FLIGHT MANAGEMENT SYSTEMS
H. P. Klein 415-965-5094

This program will investigate flight management and crew/system interaction mechanisms and requirements for current

and advanced aircraft. Specific objectives are to develop: (1) procedures for the measurement and assessment of aircrew performance for current and future systems under varied conditions of automation, ground authority, traffic complexity and environmental conditions, (2) new technology for improved current and future man system information interfaces such as navigation charts, operating manuals, warning and status annunciator systems, pilot input systems, head-up displays, and panel displays, and (3) new technology and methodology for aircrew training. To accomplish these objectives, manned full mission and part task simulations will be conducted to evaluate performance and workload measurement methodology and aircrew perception and decision making functions in a variety of tasks and mission scenarios. In-house studies, in conjunction with contracts and university grants, will be used to develop principles of optimal crew utilization and to evaluate training effectiveness. Collaborative studies with the FAA, industry and the military will be pursued to evaluate subsystems such as alerting and warning systems, head-up displays, cockpit display of traffic information and crew procedures.

W80-70055 **505-35-23**
Langley Research Center, Hampton, Va.
OCULOMETER APPLICATION TO FLIGHT MANAGEMENT RESEARCH
A. A. Spady, Jr. 804-827-3871

This research activity will be directed towards the definition of crew responsibilities and interactions, flight procedures and control and display requirements for the future civil air transportation system of the 1980-1990's. The approach to accomplishing these objectives is twofold. First, eye scan research will be conducted and data analyzed to develop scan behavior parameters that can be used as a quantitative measurement tool for assessing crew performance, the location, content and format of displays, and flight procedures. Second, an advanced eye scan data gathering system sized for use on CTOL and general aviation aircraft will be developed, which can provide data coverage over the entire cockpit for one or more crew members. These tools will be used in both simulator and flight studies, on the TCV and other aircraft, to provide real world data for determination of quantitative advanced cockpit design parameters.

W80-70056 **505-35-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
RPV UTILIZATION IN HUMAN FACTORS RESEARCH FOR HIGH PERFORMANCE AIRCRAFT
D. T. Berry 805-258-3311
(199-53-05)

This program utilizes RPV's (remotely piloted vehicles) to develop and evaluate the human factors aspects of highly integrated man/machine systems for high performance aircraft, particularly those with a single pilot. The pilot task load will be analyzed and correlated with the psychophysiological response of the pilot during the flights of manned and remotely piloted high performance aircraft. These vehicles will have advanced capabilities such as high authority augmentation systems, direct lift and sideforce, and fuselage pointing. While developing and utilizing RPV and piloted aircraft flight test techniques, cockpit configurations will be systematically varied while the effects upon pilot response are tabulated. Both controls and display will be varied during the cockpit development. This will include evaluation and optimization of remote visual systems.

W80-70057 **505-35-31**
Ames Research Center, Moffett Field, Calif.
SIMULATION TECHNOLOGY FOR AERONAUTICS
H. P. Klein 415-965-5094

The general objective of this research and development activity is to provide a scientific and technical base that can be used as a resource to develop valid, reliable and economical simulators for aeronautical research, development, and crew training. General objectives are: (1) to develop human factors principles that can be used to evaluate and guide the effective utilization of flight simulators and automated training devices and (2) to develop advanced hardware and software concepts for high fidelity simulation of vision and motion environments. The first of these two objectives will be met by continuing the study of human factors of reduced visibility scene technology, by refining an analytical method for evaluating simulator motion performance based on a human sensory processing model, and by studying the potential for improving pilot training through the use of simulation and advanced instructional strategies. The second objective will be met by improving the technology for generating and displaying heads up information in the simulator cockpit, by developing and evaluating signal conditioning techniques to reduce or ameliorate the effects of time delays in computer image generation, by developing a moving horizon system for use with terrain board visual systems and by investigating the feasibility of using advanced electric motor technology for building low cost, high performance control loader subsystems for flight simulators.

W80-70058 **505-35-33**
Langley Research Center, Hampton, Va.
APPLICATION OF FLIGHT SIMULATION TECHNOLOGY
R. L. Bowles 804-827-3304

The objective is to apply simulation technology to existing flight simulators to support Langley's research programs. This RTOP will cover both inhouse and contractual studies which address current constraints in Langley simulator equipment, in the formulation and validation of simulation math models, and in the linkage of the hardware/software systems to provide, in the closed-loop pilot/simulator environment, effective simulations. Principal tasks for FY-80 include studies of simulation requirements for directional control on runways, evaluation of kinesthetic cues for DMS and VMS, development of improved real-time simulation computing techniques for the Real-Time Simulation System, extension of and validation of the man-machine systems model for analysis of flight simulator engineering requirements, and development and application of improved interactive performance assessment techniques. Increased emphasis will be placed on the development and analysis of large-scale mission oriented terminal area simulation techniques. Results of this effort will be documented in NASA technical papers and contractor reports, and will be applied to simulations of interest to Langley Research Center.

Multidisciplinary Research

W80-70059 **505-36-11**
Ames Research Center, Moffett Field, Calif.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
G. T. Chapman 415-965-5654
(506-15-11)

It is planned to support innovative and discretionary basic research in areas related to aeronautics. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics including the technical fields of aerodynamics, fluid mechanics, flight mechanics, power, guidance and navigation, applied mathematics, propulsion and man-machine integration. The OAST Research Council and the Ames Funds for Independent Research (FIR) Committee review unsolicited proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Council and FIR Committee to be worthy of support on a scientific or engineering basis are selected as candidates for funding.

W80-70060 **505-36-12**
Lewis Research Center, Cleveland, Ohio.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
Seymour C. Himmel 216-433-4000

The objective is to support innovative and discretionary basic research in areas related to aeronautics. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics including the technical field of materials, noise,

pollution reduction, combustion, fuel, and dynamic behavior and control. Members of the Lewis Research Advisory Board, at the request of the Chief Scientist, review unsolicited research proposals that have been judged to be worthy on scientific or engineering grounds, but have not been selected for support becuase of funding limitations in other research programs. Those research proposals that are judged by the Board to be worthy of support on a scientific or engineering basis are selected as candidates for funding. These proposals are then prioritized by the Chief Scientist and funded to the extent permitted by available resources. The Chairman of the OAST Research Council is kept informed of funding plans to prevent duplication and to provide coordination. Progress and results are reported periodically by the Grant Monitor and submitted to the Chief Scientist for review and for distribution to OAST Research Council.

W80-70061 **505-36-13**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
W. D. Erickson 804-827-2471

The objective of this plan is to support basic research in universities in areas related to aeronautics through the funding of a limited number of unsolicited research proposals from various universities. University research proposals that have been judged to be well worth supporting on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs, are considered. University research proposals that have been evaluated and are not funded through any of the research programs are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be well worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be the more innovative and aimed at the longer term research of potential relevance to future NASA aeronautics programs.

W80-70062 **505-36-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FUND FOR INDEPENDENT RESEARCH
E. E. Kordes 805-258-3311

This RTOP is to support innovative and discretionary basic research in areas related to flight of aeronautical vehicles. The program pursues basic investigation of new technology in fundamental science and engineering needed to improve the performance and efficiency of aeronautical vehicles including the fields of applied mathematics and computer science, material structures, aerodynamics and fluid mechanics, propulsion systems, control systems and flight dynamics. The Research Division and the OAST Research Council review unsolicited research proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other programs. Those research proposals that are judged by the council to be worthy of support are selected as candidates for funding.

W80-70063 **505-36-21**
Ames Research Center, Moffett Field, Calif.
AERONAUTICS GRADUATE RESEARCH PROGRAM FY 1980
L. Roberts 415-965-5066

The objective of this program is to conduct aeronautical research, to develop the interest of student engineers in the field of aeronautical engineering, and at the same time either augment or enhance NASA's research programs. The approach has been to bring the Center's needs to the attention of people in the academic field. Selection of research topics is established by mutual agreement because the research must be relevant to NASA's mission and acceptable to the university. Other requirements are that the student conduct part of his work at the center and that faculty members must be involved in the program.

W80-70064 **505-36-22**
Lewis Research Center, Cleveland, Ohio.
GRADUATE RESEARCH PROGRAM IN AERONAUTICS
W. E. Moeckel 216-433-4000

Graduate research programs in aeronautics are being supported in fields of research involving fluid mechanics, engine inlet flow, fans, compressors, fuel, combustors, mechanical components, materials, engine controls, emission, and noise.

W80-70065 **505-36-23**
Langley Research Center, Hampton, Va.
GRADUATE PROGRAM IN AERONAUTICS
W. D. Erickson 804-827-2471

The objective is to support university research grants in aeronautics and associated areas in which graduate students and faculty are effectively involved in cooperative NASA-University research. The areas pursued include topics in aeronautical engineering, air transportation, and related efforts, including interdisciplinary programs. Research grants are awarded to a number of universities to pursue aeronautical research and provide support for graduate students and faculty. The graduate research is conducted at the Langley Research Center in conjunction with ongoing NASA research programs. The selection of graduate research topics is determined by joint agreement between the university and NASA staff.

W80-70066 **505-36-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
UNIVERSITY RESEARCH IN FLIGHT TESTING TECHNIQUES
E. E. Kordes 805-258-3311

This RTOP supports university basic and applied research related to improving methods and techniques in flight testing of aeronautical vehicles. The program is to promote the overall improvement in flight research through simultaneous advancement in instrumentation, testing methods, equipment, data recording, and data analysis.

General Aviation Research and Technology

W80-70067 **505-41-11**
Ames Research Center, Moffett Field, Calif.
GENERAL AVIATION AERODYNAMIC PERFORMANCE TECHNOLOGY
L. Roberts 415-965-5571

The objectives of this program are to provide an advanced technology base for the design of future aircraft that are safer, more productive, and clearly superior to foreign competition, including the development of advanced techniques and design data to improve aerodynamic performance, stability and control, and handling qualities. The approach is to use analytical prediction methods and wind tunnel measurements to develop techniques for optimizing airfoils and wing designs; to develop techniques for reducing aerodynamic drag associated with engine cooling and to develop techniques for improving stall/spin characteristics. In order for the results of this research program to be valid and meaningful, full scale tests need to be conducted in the Ames 40- by 80-Foot Wind Tunnel. This will assure the user that scale effects have been thoroughly investigated and that proper generalization can be made to new designs.

W80-70068 **505-41-13**
Langley Research Center, Hampton, Va.
GENERAL AVIATION AERODYNAMICS AND HANDLING QUALITIES TECHNOLOGY
A. W. Hall 804-827-3274

An advanced technology base will be developed to permit the design of general aviation aircraft that are safer, more productive, and clearly superior to foreign competition. This technology includes aerodynamic and propulsive performance, stability and control, and handling qualities. The work will be accomplished by computer analysis and techniques, simulator

studies, and wind-tunnel and flight tests of models and full-scale aircraft. The work will involve tests and analysis for: interference and design optimization, drag reduction, engine cooling drag, improved airfoil design capability, mission related stability, control and handling qualities criteria, improved stall/spin characteristics, and improved flight-test methods for measuring aircraft performance.

W80-70069 **505-41-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
GENERAL AVIATION MANEUVERABILITY, SAFETY AND PERFORMANCE IMPROVEMENT
D. T. Berry 805-258-3311

Experiments and studies are being conducted to identify and demonstrate optimum levels of performance, stability and control, and handling qualities for general aviation that can be achieved through the application of advanced technology. Studies are being conducted of the free-wing concept showing improvements over conventional designs in ride quality, performance, maneuverability, and safety. Two director display concepts, capable of providing curved approaches to landing, are planned to be flight evaluated. The improved tracking performance and reduced pilot workload is expected to improve the safety of flight operations.

W80-70070 **505-41-18**
Wallops Station, Wallops Island, Va.
GENERAL AVIATION AIR TRAFFIC FLIGHT DYNAMICS
W. Edward Melson, Jr. 804-824-3411

The purpose of this activity is to collect and analyze general aviation piloting procedures and aircraft flight dynamics data to provide insight to future light aircraft which are designed to be safer and in keeping with pilot operating procedures. Various data collection techniques are utilized to obtain data on aircraft flight dynamics and piloting procedures in the operating environment. These include single and multiple radar tracks in various environments, pilot questionnaires, photographic data and other techniques. Data are analyzed, integrated into simulation models, and simulations conducted to assess various design or operating alternatives. Current applications of this technology include operating stall-spin margins, mid-air collision parameters, cockpit vision envelope restrictions, automatic air traffic monitoring and control systems community noise exposure, community noise, stall-spin aircraft recovery, and effect of heavy rain on aircraft aerodynamics.

W80-70071 **505-41-22**
Lewis Research Center, Cleveland, Ohio.
ADVANCED GENERAL AVIATION PROPULSION RESEARCH
E. A. Willis 216-433-6909

The objectives are to define the technology base for, and promote the development of, improved conventional spark ignition and the most promising alternative engine(s) for general aviation use in the late 1980s. The specific improvements and/or capabilities sought are: multifuel; lower BSFC, weight, cost, and maintenance; and improved reliability, while still meeting the 1979 emission requirements. Alternative engines are being defined through studies and experimental engine tests, supplemented by experimental investigations in key technology areas. The specific work in this program is supported by contracts, grants, and Lewis in-house studies and experimental programs.

W80-70072 **505-41-33**
Langley Research Center, Hampton, Va.
GENERAL AVIATION CRASH DYNAMICS
R. G. Thomson 804-827-3795

Both analytical and experimental methods will be used to develop and demonstrate new concepts in general aviation aircraft fuselage and interior design for improved vehicle crashworthiness. Full-scale and component testing of aircraft structures will be performed inhouse to determine the basic mechanisms involved in crash behavior and energy dissipation phenomena and will provide a means of defining pertinent crashworthiness parameters. In conjunction with the experimental testing, computer programs are being developed to simulate the gross fuselage behavior during crash impact and the dynamic response of localized structural components and seat and occupant behavior. Complementary inhouse and contractual studies will be employed to establish the best analytical modeling techniques for predicting accelerations, loads, and displacements of collapsing structure. The developed computer programs will be coupled with research on load limiting seat and subfloor concepts to design modified structural components with improved crashworthy characteristics. The new concepts will be demonstrated and evaluated by full-scale and component testing.

W80-70073 **505-41-43**
Langley Research Center, Hampton, Va.
GENERAL AVIATION PROPELLER NOISE REDUCTION
J. P. Raney 804-827-2645

The objective of this research is to provide data and a technology base for reducing general aviation propeller noise with minimum weight, performance, and economic penalties. Both analytical and experimental studies are involved and work will be accomplished both inhouse and by grants and contracts. The emphasis of the analytical effort is on the prediction of both propeller noise and the aerodynamic parameters which determine propeller noise. The emphasis of the experimental program is on evaluating noise prediction/reduction technology through model-scale tests with flight evaluation and demonstration of technology as required. Noise prediction is used both as a tool for developing noise reduction technology and to identify technology areas requiring further research.

W80-70074 **505-41-52**
Lewis Research Center, Cleveland, Ohio.
LOW-SPEED PROPELLER TECHNOLOGY
D. C. Mikkelson 216-433-6820

The objective of this program is to advance the technology of propellers for General Aviation aircraft to reduce energy consumption, lower noise and improve aircraft safety. This program encompasses analytical and experimental work on propeller performance, acoustics, aeroelastic characteristics and low cost composites. GAP advanced technology will be oriented toward aircraft in the following categories: (1) low speed-low power (up to 200 kts with up to 250 h.p.); (2) high speed-high power (turboprop); and (3) low speed-high power (up to 100 kts with 600-1000 h.p.-ag. aircraft).

W80-70075 **505-41-63**
Langley Research Center, Hampton, Va.
GENERAL AVIATION AVIONICS AND CONTROLS TECHNOLOGY
D. R. Downing 804-827-3551

The objective of this work is the development of advanced navigation, guidance and control technology, and sensor and actuator components which will enhance the safety and utility of general aviation aircraft. The approach is to develop and evaluate in simulation and flight tests advanced navigation, guidance, control, sensor and actuator technology. State-of-the-art guidance and control theory will be extended and modified for application to GA aircraft operation. Advanced navigation systems and onboard computation capabilities will be used to improve the performance and safety of GA operations. Examples are improved ride quality and IFR terminal area operation along curved paths. Fluidic and electronic sensors and control surfaces will be developed that replace expensive low reliable components, e.g., mechanical gyroscopes. Improved performance and increased capabilities without increased avionics cost are design goals.

W80-70076 **505-41-68**
Wallops Station, Wallops Island, Va.
GENERAL AVIATION AVIONICS AND CONTROLS RESEARCH
Lloyd C. Parker 804-824-3411

The objective is to demonstrate the systems feasibility of utilizing advanced low cost digital systems technology to provide (1) automatic voice airport advisory information at uncontrolled airports of weather conditions, active runway and existing hazardous conditions for VFR and IFR traffic; (2) automatic voice air traffic and mid-air collision advisories to traffic at uncontrolled airports using standard NAV-COM frequencies without transponder

requirements; and (3) synthetic voice response digital technology as a means of increased ground to air communications capacities. The approach includes studies of systems concepts, systems definition, engineering model development, evaluation and demonstration of technology improvements achieved.

W80-70077 **505-41-73**
Langley Research Center, Hampton, Va.
GENERAL AVIATION - SINGLE PILOT IFR SYSTEMS
J. D. Shaughnessy 804-827-3917

This effort will provide the background research and develop the technology required to improve the safety and utility of single-pilot general aviation (GA) aircraft operating under instrument flight rules (IFR). Functional roles and requirements of the IFR pilot will be determined for current as well as future air traffic systems. The pilot environment, psychological state, workload, required actions, and the interrelationship between these factors will be defined and characterized so pilot effectiveness can be maximized. Aircraft and subsystem requirements will be assessed and design data and guidelines will be developed for systems that significantly aid the single pilot flying under IFR. It will be determined if selected modifications to ATC procedures, aids, and pilot training might improve safety and ulility of single pilot IFR operations. Analyses, simulation studies, and flight tests will be performed on various cockpit display formats, automatic and manual control systems, advanced avionics systems, flight data consoles, microprocessor applications, multi-mode displays, flying qualities, procedural and other software concepts, speech synthesis and recognition capability, advanced ATC concepts, and advanced information and flight management systems.

W80-70078 **505-41-82**
Lewis Research Center, Cleveland, Ohio.
AERIAL APPLICATIONS DISPERSAL SYSTEM TECHNOLOGY
W. C. Strack 216-433-6167

Existing and new technologies for dispersal system improvement will be evaluated analytically. Improvement in liquid droplet size uniformity is specifically sought, although conceptual improvements in automatic flow control will also be addressed.

W80-70079 **505-41-83**
Langley Research Center, Hampton, Va.
AERIAL APPLICATION AERODYNAMICS AND SYSTEMS INTERACTION
A. W. Hall 804-827-3274

The objective of aerial applications research is to improve the effectiveness and efficiency of agricultural production systems through application of aeronautical technology. Specifically, the technology will be developed for both short- and long-term improvements in the accuracy of distribution, environmental, health, and safety aspects of aerial applications and improvements in aircraft aerodynamics, flight controls, structures, and dispersal systems.

Low-Speed Aircraft Research and Technology

W80-70080 **505-42-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT AEROELASTICITY AND STRUCTURAL DYNAMICS
M. Kelly 415-965-5033

The objective of this research is to improve the predictive capability for rotorcraft loads, vibration, aeroelastic stability, and performance; and where possible to develop rotors with improved dynamic characteristics. This will be accomplished by developing and verifying advanced analytical models for rotorcraft, with particular emphasis on the structural dynamics and aeroelectricity. It is important to note that the level of predictive capability required depends on the type of aircraft considered as well as on the technology level. For some simple, well understood rotor systems a satisfactory predictive capability may have already been achieved; for new rotor systems and rotorcraft configurations additional work will always be required. The accuracy of current and improved models of rotor dynamics must be assessed by comparison with experimental data. As appropriate, small scale and large scale wind tunnel tests will be conducted in order to define dynamics problems and verify and improve advanced analytical models. This research will also involve the development of data reduction and data management techniques to allow the best use of the experimental data.

W80-70081 **505-42-13**
Langley Research Center, Hampton, Va.
ROTORCRAFT STRUCTURES, VIBRATION, AEROELASTICITY, AND ACOUSTICS
E. E. Mathauser 804-827-2036
(505-02-13)

Research and development will be conducted to establish the durability of composite structures through flight service and ground testing of numerous secondary and primary helicopter components. Structural criteria will be developed for lightweight composite helicopter structures. Analytical and experimental studies will be conducted to reduce helicopter vibrations and internal noise levels. Reduced vibration levels in civil and military helicopters will lead to increased reliability, maintainability, passenger acceptance and crew comfort. Wind tunnel models will be tested to measure rotor vibratory loads. A timely evaluation will be carried out, with industry-wide concurrence, of the applicability of finite element methods for practical analysis of helicopter airframe vibrations, and to establish recommendations for any future development of these methods. Analytical and experimental studies will be made to identify factors contributing to the aerodynamic, acoustic, and aeroelastic characteristics of rotors.

W80-70082 **505-42-21**
Ames Research Center, Moffett Field, Calif.
AERODYNAMIC PERFORMANCE, DYNAMICS AND HANDLING QUALITIES
L. Roberts 415-965-5066

This research covers on all aspects of rotor aeromechanics (aerodynamics, dynamic loads and stability, performance, and noise characteristics) and rotorcraft flight dynamics. Flight dynamics research will be conducted to provide handling qualities and design criteria which permit cost effective design decisions to be made for helicopters for specific missions. The research will be conducted through analysis, including math model improvement and development of advanced techniques of control systems implementation; ground based piloted simulation; and flight research with the UH-1H (with V/STOLAND), CH-47, and CH-53 aircraft. The understanding and predictive capability of the aerodynamic and dynamic phenomena of advanced rotorcraft will be improved by conducting analytical, small scale, and full scale experimental investigations of helicopter performance and noise; rotor aerodynamics and wake characteristics, drag and aerodynamic interference; and rotor loads, vibration, and vibration reduction systems. Specific advanced rotor configurations will be tested in the full scale wind tunnel. Theoretical and experimental research will be conducted to develop techniques to design optimum airfoils for rotary wing applications and to predict their dynamic performance, particularly at high subsonic and transonic speeds. The benefits of optimum airfoil sections upon complete rotor performance will be studied, and methods for predicting optimum tip shapes will be developed. Analytical models for the flow about rotorcraft fuselages will be developed.

W80-70083 **505-42-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ROTORCRAFT FLIGHT TESTING
H. P. Washington 805-258-3311

The objective is to develop flight test experience and capability by working closely with the U. S. Army Aviation Flight Activity at Edwards Air Force Base. The approach being pursued is to detail NASA personnel to the Army Flight Test Facility and to engage with the Army in cooperative programs where the Army benefits by using Dryden's facilities and expertise and Dryden in turn picks up valuable rotorcraft flight testing experience.

Agreements have already been made between Dryden and the Army to cooperate on several Army programs while other candidate programs for a cooperative effort are under consideration.

W80-70084 **505-42-31**
Ames Research Center, Moffett Field, Calif.
INTEGRATED AVIONIC CONTROL SYSTEM FOR ROTORCRAFT
C. T. Snyder 415-965-5567
(505-42-41)

Advanced control technology will be developed to provide effective integration of airframe, propulsion, and subsystem control functions to enhance the performance, economic viability and safety of future V/STOL aircraft and rotorcraft. Studies of a total automatic flight control system (TAFCOS), which uses a combination of open loop and closed loop controls, will continue using the UH-1H helicopter. In addition, the TAFCOS concept will be extended by applying it to the design of a flight control system for the tilt rotor aircraft, and evaluating the performance of the resulting system. A methodology for the system design and analysis will be developed. This methodology will include the development of software, and a distributed fault-tolerant network of microprocessors. The necessary information/display concepts for adequate redundancy management will also be defined and developed. Advanced concepts of redundant actuator systems will be studied, and suitable redundancy management techniques developed, with specific attention to system performance, failure effects, reliability and maintainability. The redundant actuation systems will be combined with the fully developed TAFCOS system, into a total integrated flight control system. This total system will be evaluated in terms of safety, cost, reliability, and maintainability, using principally manned simulations, and, if necessary, flight tests.

W80-70085 **505-42-51**
Ames Research Center, Moffett Field, Calif.
HEAVY-LIFT/SHORT-HAUL AIRSHIP TECHNOLOGY
W. H. Deckert 415-965-5888

The objective is to provide aerodynamics, flight dynamics, and control systems technology development for promising modern hybrid airship concepts. Emphasis will be on the flight dynamics simulation of a hybrid airship concept, called the buoyant quad-rotor, employing substantial amounts of rotor forces for lift and control and designed for transporting heavy payloads over short ranges. In addition to the buoyant quad-rotor concept, other heavy-lift/short-haul hybrid airship concepts will be studied, including those with turbo-prop and ducted-fan propulsive-lift systems, possibly in combination with rotor systems. The program is currently concentrating on areas known to have the greatest uncertainties: modeling and control of interconnected rotors, aerodynamic interactions of rotors and envelopes, and gust and turbulence modeling. Follow-on efforts will concentrate on effects of structural flexibility and control law development. The work to be done includes analytical studies, computer simulation, wind tunnel testing, and design studies.

W80-70086 **505-42-62**
Lewis Research Center, Cleveland, Ohio.
V/STOL PROPULSION RESEARCH TECHNOLOGY
Carl C. Caiepluch 216-433-6644

An efficient lightweight, reliable lift/cruise propulsion system is a critical requirement for the successful design of V/STOL aircraft. The technology base to provide the required system will be developed in selected critical areas which are unique to the V/STOL concept. Analytical and experimental analysis will be conducted in the areas of fans, inlets, thrust defector nozzles, thrust control devices, ejectors and a full scale STOL engine.

W80-70087 **505-42-71**
Ames Research Center, Moffett Field, Calif.
ADVANCED VTOL AIRCRAFT AERODYNAMICS AND FLIGHT DYNAMICS RESEARCH
L. Roberts 415-965-6373

The objective of this RTOP, which is a companion to RTOP 532-05-11, is to develop basic research and technology required to enable the development of military and civil aircraft having VTOL capability and viable mission performance. Theoretical and experimental generic research will be undertaken in the areas of high speed aerodynamics, low speed aerodynamics, and flight dynamics. To insure that all major high speed propulsion system/airframe interactions are accounted for properly, compact propulsion simulator technology will be developed for use in scale wind tunnel models of VTOL configurations. Methods for predicting high speed aerodynamic performance and forebody/inlet interactions will be refined. Low speed wind tunnel aerodynamic research will concentrate on development of aerodynamic prediction techniques for both transition and ground effects, improvement of experimental techniques, and evaluation of methods for efficient control of VTOL aircraft in hover. Flight control system and display requirements will be investigated concurrently, primarily through piloted simulation. The flight control and display requirements obtained from simulation will be verified for all VTOL flight phases when a suitable research aircraft becomes available.

W80-70088 **505-42-74**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AV-8A V/STOL FLIGHT FACILITY
J. A. Albers 805-258-3311

The AV-8A program centers around the expansion of technology in V/STOL flight dynamics through flight test techniques providing parameter identification data for improving ground base simulation models. The flight experiments will include evaluation of the AV-8A aircraft to enhance the V/STOL flight data base in flight dynamics and operating systems, developing flight test techniques for high disk loading V/STOL aircraft, comparing these data to existing ground based data and establishing a benchmark for future V/STOL aircraft.

High-Speed Aircraft Research and Technology

W80-70089 **505-43-11**
Ames Research Center, Moffett Field, Calif.
FLIGHT VEHICLE DYNAMICS
Richard H. Petersen 415-965-5851

The research is to provide a basic understanding of the aerodynamic and flight dynamic characteristics of highly maneuverable aircraft through the development and utilization of improved wind tunnel measurement and analytic techniques, including both static and dynamic methods. Ultimately, through application of improved methods of testing and application of the test results including better simulations resulting from improved aerodynamic mathematical models, new criteria can be established for designing vehicles capable of performing controlled maneuvers over an expanded angle of attack envelope. Investigations are in progress to evaluate various experimental methods for determining dynamic characteristics of aircraft, and experimental capabilities are being upgraded for testing at high angles of attack and high Reynolds numbers, both for static and dynamic characteristics. Dynamic apparatus are being investigated or constructed to evaluate aerodynamic coefficients which are pertinent to all phases of high-maneuver flight from controlled motions to fully developed spins. Basic investigations are in progress to provide fundamental understanding of fuselage aerodynamics at high angles of attack.

W80-70090 **505-43-13**
Langley Research Center, Hampton, Va.
FLIGHT DYNAMICS
J. R. Chambers 804-827-2184

The broad objective is to improve the stall/spin characteristics of aircraft, and to determine the effects of these characteristics in terms of piloting the aircraft. Specific objectives are: (1) to investigate the fundamental nature of stall/spin including the development of test techniques and methods for theoretical analysis; (2) to develop and evaluate the effectiveness of automatic spin prevention concepts; (3) to determine static and dynamic aerodynamic characteristics of current and advanced configura-

tions at high angles of attack; and (4) to determine geometric characteristics which result in inherent spin resistance. The methods of approach include static and dynamic wind tunnel force tests, theoretical analysis, piloted simulator tests, and dynamic model flight tests. Extensive participation in DOD airplane development programs is involved.

W80-70091 **505-43-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT DYNAMICS AND HANDLING QUALITIES
D. T. Berry 805-258-3311

The overall objective of this effort is to develop a better understanding of the basic phenomena, improved analytical and experimental techniques, and new concepts related to dynamic and handling quality characteristics of aircraft in all flight regimes. Studies will be conducted to develop analytical techniques for determining stability and control derivatives from flight data, to develop new techniques for evaluating handling qualities, for achieving desired aircraft responses and to develop improved aeroelastic aircraft analysis techniques. Analytical studies, computer algorithm development and programming, and flight tests will be performed both inhouse and under contract and grants to meet these ojectives. Improved techniques for estimating the unknown parameters of the math model and for improving the identifiability of the systems will be studied on flight test data. The stochastic control based on the estimates will then be tested in flight to assess the improvement of the system. Also the range of command responses of augmented vehicles that optimizes pilot-vehicle performance for a specific mission or task within a mission will be investigated. Emphasis will be on criteria for command responses that are meaningful to system designers.

W80-70092 **505-43-21**
Ames Research Center, Moffett Field, Calif.
HIGH PERFORMANCE AIRCRAFT AIRFRAME-PROPULSION INTEGRATION
R. H. Petersen 415-965-5881

The objective is to investigate airframe/propulsion system integration for advanced combat aircraft. Conceptual designs of such aircraft have incorporated a number of new features that potentially impact the integration of the airframe and propulsion system. Among these include the use of canards and strakes in close proximity to or even in front of the inlet. This is especially true in the case of top mounted inlets which are presently being considered by industry. With the demand maneuvering requirements associated with these vehicles, there will be a significant interaction between these components leading to potentially severe integration problems. To investigate these interactions, analytical techniques presently being developed to analyze canard/wing flow fields will be extended to handle the canard/strake/inlet problem. Furthermore, one of the available VSTOL fighter configurations presently scheduled for wind tunnel testing will be selected and appropriately modified to investigate the canard/strake/inlet interactions in more detail. Comparisons will be made between the analytical and experimental results.

W80-70093 **505-43-22**
Lewis Research Center, Cleveland, Ohio.
COMBAT VEHICLES & MISSILE AERODYNAMICS & FLIGHT DYNAMICS R & T
Ross G. Willoh 216-433-6624

The objective of this program is to establish through analytical studies, system design efforts, and full scale test programs the technology base required for the application of unique configurations to future combat aircraft. Current activities are specifically directed toward providing the technology required for the design of non axisymmetric exhaust nozzles for turbine engines. The high maneuverability requirements anticipated in future aircraft designs lead to the application of nonaxisymmetric nozzles capable of thrust vectoring and reversing. Experimental and analytical efforts will be undertaken to improve the technology available for the design of non axisymmetric exhaust systems. Principle areas of concern will include cooling, heat transfer, structural design, weight and internal aerodynamics. The objectives will be accomplished through contract studies, nozzle design, fabrication, and altitude testing. Particular emphasis will be placed on solutions to the complex cooling, structural and internal aerodynamic problems associated with on axisymmetric nozzles. Close coordination will be maintained with Langley Research Center and the Air Force to assure that work in the propulsion area appropriately supports Air Force requirements and the aerodynamic work at Langley.

W80-70094 **505-43-23**
Langley Research Center, Hampton, Va.
COMBAT VEHICLE AND MISSILE AERODYNAMICS AND FLIGHT DYNAMICS
C. M. Jackson 804-827-3134

The technical objective of this work is to develop the aerodynamic technology base for the design of future military aircraft and missile concepts. Analytical and experimental studies will be made to develop aircraft design rationale and evaluate advanced aerodynamic concepts such as supercritical aerodynamics, wing wrap, maneuver devices, thrust-induced lift, nonaxisymmetric nozzles, and component interference. Similar studies will be made to expand the aerodynamic technology base for missile systems including conventional cruciform stability and control concepts, airbreathing propulsion integration, and monoplanar concepts. Studies will also be made to provide a technology base for evaluation of missile carriage and separation aerodynamics.

W80-70095 **505-43-31**
Ames Research Center, Moffett Field, Calif.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
L. Roberts 415-965-5066

Technical assistance, consultive services and support, through the use of NASA facilities, will be provided to outside agencies and the aircraft industry. Principal assistance is to the Department of Defense (DOD) for aircraft and missile systems development programs. Additionally, joint activities will be conducted with other government agencies and industry on a fee or reimbursable basis. Areas of support include research activities to aid in assuring satisfactory aerodynamic and handling qualities of piloted aircraft in routine operational flight and in advanced weapon delivery tasks, and in assuring satisfactory flight path and attitude control of these aircraft in given automatic flight modes, such as radar-guided approaches and landings on an aircraft carrier. Also included are efforts to define and develop techniques for improvement of marginal or unsatisfactory characteristics of new airplane designs. Wind tunnels, flight simulators, and central computer facilities (360, 7600), together with applications of advanced control theory, will be employed as required. Specific systems for which support is planned during FY-80 include: AV-8, F-18, Advanced Fighter Technology Integration Program (AFTI), Submersible Bodies, Douglas DC-10, Douglas AST, NASA/MBB Inlet, Boeing 777, Boeing C-14, Advanced Missiles, Circulation Control Rotor, X-Wing Rotor, XV-12A and Heliostat.

W80-70096 **505-43-32**
Lewis Research Center, Cleveland, Ohio.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
D. N. Bowditch 216-433-6123

The objective is to support requests from the Department of Defense, Department of Transportation and other Federal agencies outside NASA for aerodynamic testing in the facilities of the Lewis Research Center. Facilities typically used under this RTOP include 10X10 SWT, 9X15 WT, icing tunnel and PSL.

W80-70097 **505-43-33**
Langley Research Center, Hampton, Va.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
W. J. Alford 804-827-2396

The broad objective is to provide technical assistance and consultative services to outside agencies and the aircraft industry programs which involve specific requests for NASA support. The principal assistance is to the Department of Defense

for aircraft and missile development programs. Current activity is focused in the areas of stall/spin; aerodynamic characteristics at subsonic, transonic, and supersonic speeds, flutter and aeroelasticity; structures; landing loads and simulation. The approach will involve tests in applicable Langley facilities consistent with the availability of test time and the utilization need for the particular facilities requested. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pretest conferences, technical evaluation boards, and technical coordination committees.

W80-70098 **505-43-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
INTERAGENCY ASSISTANCE AND TESTING
E. N. Videan 805-258-3311

This RTOP is intended to cover interagency assistance using applicable DFRC flight test facilities consistent with availability and utilization needs for these facilities ralated to approved ongoing programs. The broad objective is to provide technical assistance, consultative services and test facility support to DOD for military programs and to industry, which involve specific requests for NASA support. Recent activities of this kind include a B-52 drop test for recertification of the F-111 crew escape system; and component improvement tests involving F-15, T-37, and F-111 aircraft. Current activities include support of the AFTI-16 (F-16) program and some as yet undefined support of the Navy F-18 airplane and subscale submarine inertia measurements. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pre-test conference, technical evaluation boards, and technical coordination committees.

W80-70099 **505-43-44**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
REMOTELY PILOTED RESEARCH AIRCRAFT TECHNOLOGY
W. H. Andrews 805-258-3311

This RTOP covers the effort in two areas, the RPRV/RAV Facility development program, and the AD-1 oblique wing research airplane. RPRV/RAV facility development covers the continuing remotely piloted research vehicle (RPRV) development to improve the capability of flight testing high performance and highly maneuverable vehicles of the future. The remote augmented vehicle (RAV) facility development will continue to cover conceptual investigations of several candidate interfaces, simplex ground computers and multichannel airborne fly-by-wire control systems. This effort will include pilot-in-the-loop control, failure modes, and error analyses for those systems. The manned low-speed AD-1 jet Oblique Wing research airplane construction is complete and the airplane was delivered on March 11, 1979. The flight program objectives are designed to provide a data base and an additional level of flight experience.

W80-70100 **505-43-54**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AIRCRAFT OPERATIONAL SUPPORT
R. S. Waite 805-258-3311

Equipment, maintenance, and operation are provided for support aircraft including (2) F-104N, (3) F-104G, (1) T38 and C-47; and service aircraft including B-52, PA-30, and JetStar. Major effort and coordination of activities is provided by inhouse resources with augmentation by supporting contractors (engine maintenance, AGE maintenance, inventory management) and reimbursable military elements (fuel, parts, special functions). The Aero Commander and Bell Helicopter are included in FY-1979. This effort supports research flight programs, providing adequate proficiency of pilots, chase aircraft, R/D support in terms of research investigations and general operational support.

Transport Aircraft Research and Technology

W80-70101 **505-44-11**
Ames Research Center, Moffett Field, Calif.
AVIATION SAFETY TECHNOLOGY (IN-FLIGHT DETECTION AND PREDICTION OF CLEAR-AIR-TURBULENCE AND WIND SHEAR)
C. T. Snyder 415-965-6219
(505-08-21)

The objective is to improve aviation safety by providing detectors of upstream atmospheric disturbances. The tasks are to investigate the potential of an infrared sensor system to provide an in-flight cockpit alert warning of upcoming clear air turbulence (CAT) encounters during cruise phases of flight, and of wind shear encounters during the terminal areas operations and landing approach phase of flight. Various filter systems will be analyzed and calibrated in order to optimize the sensor output for a desired alert lead-time. Various algorithms will be studied for use as signal analyzers and cockpit alert signal drivers. Flight testing will include piggyback experiment testing the NASA C-141 and VV-990 flying laboratories. The program is a joint study between NASA-Ames and NOAA-Environmental Research Labs.

W80-70102 **505-44-12**
Lewis Research Center, Cleveland, Ohio.
AIRCRAFT ICING RESEARCH
R. W. Luidens 216-433-4000

The objective of this program is to update and advance the technology related to the safe and efficient operation of aircraft under atmospheric icing conditions. The program will be broad based, encompassing both analytical and experimental research, and conducted using both in-house and contracted effort. It will be performed as a coordinated effort between the aircraft industry/users, Government agencies and the military. NASA will serve as the focal point for assembling a wide range of data and for dissemination of the data.

W80-70103 **505-44-13**
Langley Research Center, Hampton, Va.
AVIATION METEOROLOGY RESEARCH - SEVERE STORMS
A. W. Hall 804-827-3274

A technology base will be developed to improve the knowledge and understanding of atmospheric processes as they affect the design and safe and efficient operation of aircraft and aircraft systems. This will be accomplished by experimental and analytical programs aimed at providing an understanding of the predictability and the detectability and avoidance of hazards of severe storms to aircraft operations. These hazards include wind shear, turbulence, lightning, precipitation, and icing. Protection against direct lightning strikes will be studied.

W80-70104 **505-44-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
KNOWLEDGE OF HIGH ALTITUDE ATMOSPHERIC PROCESSES
T. R. Sisk 805-258-3311

The objective of this work is to improve the definition of atmospheric characteristics required for advanced aircraft design and for more efficient, sage aircraft operation. Phenomena which are emphasized include clear air turbulence, wind shear, temperature transients, pressure altimetry problems and aircraft icing. Data on these phenomena are obtained from instrumented aircraft and are related to the meteorological conditions causing them by the use of mathematical models and climatological information. This work covers the study efforts, both in-house and on contracts or grants, as well as the development and acquisition of sensors needed to measure the atmospheric phenomena. Results of this work are applicable to aircraft system design, flight test activities and flight operations.

W80-70105 **505-44-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MICROWAVE TECHNOLOGY DEVELOPMENT FOR ATMOSPHERIC TURBULENCE STUDIES
B. L. Gary 213-354-3198

This RTOP is an outgrowth of experience with an airborne microwave radiometer during the recent NASA CV-990 Clear Air Turbulence flight series. During these flights it was demonstrated that temperature structure in the altitude vicinity of the aircraft can be remotely sensed using passive microwave techniques, and that on some occasions turbulence is located within these temperature structures. This study has two goals: (1) to fly an improved Temperature Structure Radiometer, TSR, in ways that systematically explore the association of CAT with good quality retrievals of vertical temperature structure, with the aim of evaluating CAT avoidance strategies; and (2) to employ the high spatial resolution capabilities of the improved TSR to evaluate the usefulness of monitoring horizontal (temporal) inhomogeneities of the temperature field for the purpose of issuing yes/no warning for CAT encounters. It is proposed that these studies be conducted from a Learjet for studies in the troposphere altitude regime, and that an attempt be made to install a modified version of the TSR in NASA's C-141, Kuiper Flying Observatory, for studies in the tropopause/low stratosphere altitude regime.

W80-70106 **505-44-18**
Wallops Station, Wallops Island, Va.
ATMOSPHERIC DYNAMICS AND MEASUREMENT TECHNIQUES
Loyd C. Parker 804-824-3411

The objective is to collect, analyze and model severe low-altitude wind shear, turbulence and storm outflow dynamics data as they apply to the safe and efficient operations of aircraft and aircraft systems; and to identify and test advanced sensors for automatic measurement of prevailing visibility, ceiling heights and wind shear. The comprehensive meteorological measuring systems existing at Wallops Flight Center will be utilized to collect data associated with significant meteorological phenomenon related to aircraft operating safety. Systems applicable to this research include: two meteorological towers (250 ft. and 300 ft.) instrumented with two and three dimensional anemometers and other sensors, precision wind profile balloons and radiosondes, precision video and doppler radars, lidars, a fully equipped NWS observation service and equipments, and instrumented test aircraft. Experiments will be configured to provide intense coordinated measurements during severe and/or significant meteorological events. Emphasis will be placed on low-altitude spatial changes as related to the specific aircraft operating problem during approach and departure flight phases and in identification of advanced meteorological sensor characteristics to meet current operational needs.

W80-70107 **505-44-19**
Marshall Space Flight Center, Huntsville, Ala.
AVIATION METEOROLOGY RESEARCH - BASIC ATMOSPHERIC PROCESSES
Dennis W. Camp 205-453-2087

The objectives are (1) to define, investigate, and model those atmospheric conditions adverse to aircraft operations and possibly conducive to aircraft mishaps; and (2) to conduct research relative to development of techniques, procedures, and the need for new and/or improved meteorological instrumentation whereby acquired knowledge of the natural environment can be better utilized for safe operation of aeronautical systems. The approach will be to continue (1) to measure and analyze atmospheric data; (2) to develop models of atmospheric boundary layer properties and the conditions which lead to or intensify them; (3) to perform analytical, laboratory, and field tests relative to investigation of warm fog; and (4) to develop and/or modify instrumentation as needed to meet the requirements of this approach. To accomplish the objectives, the following tasks will be performed: (1) correlation of lateral and longitudinal gusts and their effects on aeronautical systems, and conduct of an aviation meteorology workshop; (2) atmospheric dynamics process definition as related to aeronautical system operations; (3) warm fog investigative studies relative to life cycle, modification, and dispersion; (4) investigation into buildup and dissipation of frost on the surface of an aircraft and conduct of a field test program of frost effects on aeronautical systems; (5) development of new or improved instrumentation for safer operation of aeronautical systems; and (6) atmospheric electricity as related to aeronautical systems.

W80-70108 **505-44-21**
Ames Research Center, Moffett Field, Calif.
AVIATION SAFETY TECHNOLOGY - OPERATION PROBLEMS & FIREWORTHINESS
C. T. Snyder 415-965-6219

The objective is to improve aviation safety by increasing the understanding of the causes of accidents, and by developing systems technology and piloting techniques for avoiding hazards leading to accidents. Research on post-accident analysis techniques is a cooperative program with the National Transportation Safety Board, Bureau of Aviation Safety (NTSB-BAS). The general objective is to develop improved data processing techniques for analyzing aircraft accident recordings. Additionally, as part of a joint NASA/FAA program, simulator investigations will be conducted on the effectiveness of integrated head-up displays (HUD) on reducing hazards associated with wind shear and low visibility in the landing approach for CTOL. Research will also be conducted in new technology to enhance the operational safety of IFR operations for civil and military rotorcraft and VTOL aircraft.

W80-70109 **505-44-22**
Lewis Research Center, Cleveland, Ohio.
AIRCRAFT PROPULSION SYSTEMS SAFETY TECHNOLOGY
S. Weiss 216-433-5166

Provide a broad base of safety oriented technology for identifying, defining and dealing with hazards associated with aeronautical propulsion systems. Establish criteria for systems design and operating techniques leading to reduction in accidents, loss of life and injuries, and loss of equipment. Support and perform research and technology activities that lead to solutions of problems impacting on aviation safety with particular emphasis on propulsion systems. Coordinate activity results with the FAA, NTSB, DOD, other interested Government agencies and the aviation community. Specific areas of current activities include: (1) general aviation engine tolerance to substitute fuels; (2) crash fire prevention; and (3) systems safety analyses.

W80-70110 **505-44-23**
Langley Research Center, Hampton, Va.
AVIATION SAFETY TECHNOLOGY - FLIGHT SAFETY
A. W. Hall 804-827-3274

A technology base will be developed which can be used to reduce the number of aviation accident opportunities and to minimize the fatalities and damage resulting from accidents. This will be accomplished by programs aimed at providing a data base for continued knowledge of the usage of various types of aircraft relative to their original design criteria. Research on equipment and systems will be undertaken to improve the accuracy and reliability of operational information relative to visibility and meteorological phenomena. Research will also be conducted to provide improved protection of the aircraft and its systems from hazards such as lightning, turbulence, and wind shear.

W80-70111 **505-44-25**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AVIATION SAFETY TECHNOLOGY - APPLIED FLUID MECHANICS
Paul F. Massier 213-354-3549

The overall objective of this effort is directed toward improving aircraft fire safety. The studies include those aspects of safety associated with: (1) the determination of rheological properties of modified antimisting jet fuel which are responsible for inhibiting the ignition of fuel during a survivable aircraft crash; (2) the development of an enclosure fire modeling methodology for the prediction of aircraft fire characteristics and the associated dynamic response of materials in an accidental fire environment; and the analysis and prediction of the thermal characteristics of external

pool fires resulting from post-crash fuel spills in order to characterize the fire hazards; and (3) the prediction of the thermal performance (ignition delay, burn rate and smoke evolution) of complex materials and structures by utilizing fundamental physicochemical property values, and development of scaling rules.

W80-70112 **505-44-27**
Lyndon B. Johnson Space Center, Houston, Tex.
AIRCRAFT FIRE SAFETY AND TESTING
R. W. Bricker 713-483-3166

The effort defined in this RTOP consists of work originated in FY-75. The RTOP provides for the procurement of manpower for testing aircraft fuselage sections fabricated with newly-developed materials; testing functional size elements in the JSC 737 fuselage; preparing the 737 fuselage and fitting it with instrumentation for conducting full-scale flamability tests; computer support; and evaluation, analysis, and delivery of technical data and reports.

W80-70113 **505-44-28**
Wallops Station, Wallops Island, Va.
AVIATION OPERATIONS SAFETY TECHNOLOGY - WIND SHEAR
Loyd C. Parker 804-824-3411

The objective is to determine the feasibility of utilizing existing weather radars or other aircraft equipments to provide aircraft ground speed and wind information necessary for detection of hazardous wind shear conditions during flight below 1500 feet altitude. State-of-the-art pulse, solid state CW, coded CW and pulse-Doppler radar technology will be evaluated and tested as a means of determining aircraft ground speed, wind shear profile in rain and as a possible means of ground wind speed uplink to aircraft.

W80-70114 **505-44-29**
Marshall Space Flight Center, Huntsville, Ala.
AVIATION SAFETY TECHNOLOGY - APPLIED LASER TECHNOLOGY
E. A. Weaver 205-453-1597

Electro-optic sensors using lasers will be developed for application to aircraft operations and safety problems. The primary objective for FY-80 will be the evaluation of doppler lidar test data and the development of operational requirements and specifications for a lidar clear air turbulence (CAT) detection system. Remote measuring of atmospheric flow systems will use infrared lasers. Other coherent light frequencies will be used as defined by the systems analysis studies of a specific problem. System engineering studies will identify the research hardware design specifications for use in building the required feasibility demonstration sensor systems.

W80-70115 **505-44-31**
Ames Research Center, Moffett Field, Calif.
AIRCRAFT SYSTEMS OPERATIONAL SAFETY EFFICIENCY IMPROVEMENT
P. M. Sawko 415-965-5954

The objective of this program is to improve aircraft safety and efficiency through the use of advanced materials in aircraft tires. This involves the evaluation of new tire formulations comprised of a 60 tire set that will compare the latest baseline tire to two experimental tire formulations. This tire test will be conducted at the Langley Research Center to identify the relationship between runway surface conditions, tire composition and chevron cut growth. If these wear and friction tests show improvement, the best experimental tire composition will be selected for further tests. This will require a 50 experimental tire set plus a 50 baseline tire set (NR/CB) to be fabricated for life cycle performance tests.

W80-70116 **505-44-32**
Lewis Research Center, Cleveland, Ohio.
COMMERCIAL AIRCRAFT FUEL SAVINGS
J. J. Ward 216-433-6240

The objective is to demonstrate through impact studies that near real-time high resolution flight-level wind field and temperature data can provide the basis for increasing the accuracy of the airline flight plan (minimum time track profile) and that this improvement can result in substantial savings in fuel for the airline industry. To achieve this objective, comparisons will be made between flight plans developed from the present operational data base and those developed from enroute high resolution wind and temperature data. These results will then be evaluated against actual data provided by participating airlines. The minimum time track requirement for the flight plan provides unique criteria with which to translate the results of these comparisons directly into fuel savings for air carriers. The high resolution wind field and temperature data base required for this impact study will be available, for the first time, along several major airline routes as a result of an international meteorological experiment scheduled to begin in December 1978 and run for 12 months.

W80-70117 **505-44-33**
Langley Research Center, Hampton, Va.
AIRCRAFT LANDING SYSTEMS EFFICIENCY IMPROVEMENTS
J. L. McCarty 804-827-2796

The specific objective is to examine new concepts and techniques which offer potential for reducing both operational complexities and costs of aircraft landing systems with a view toward use of the improved systems by large and small civil aircraft. Aircraft operations on prepared runways under adverse weather conditions and on certain unprepared surfaces present requirements of braking and steering systems, tires, and the runway that are vital to aircraft safety and passenger comfort. The objectives of programs covered by this RTOP are (1) to improve the performance of braking systems, (2) to improve the wet traction and lifetime of pneumatic tires, (3) to develop new landing gear systems that would permit operations on unprepared fields, including water, and permit continuous use of prime runways for all-weather operations, (4) to evaluate tire cornering behavior with and without braking such that high-speed turnoffs can be designed to increase the flow of traffic at congested airports, and (5) to relate the character of the runway surface to aircraft braking and steering performance. Research to meet these objectives will employ full-scale aircraft landing gear systems and subsystems, and scaled pneumatic tires. The landing loads track will be the primary test facility.

Aeronautics Systems Technology Programs

W80-70118 **510-53-12**
Lewis Research Center, Cleveland, Ohio.
MATERIALS FOR ADVANCED TURBINE ENGINES (MATE)
C. P. Blankenship 216-433-6922

The MATE program is a cooperative Government-industry effort to help introduce new materials technologies into advanced aircraft turbine engines in order to more rapidly achieve potential economic and operational performance advantages. The general objective is to advance the development of selected materials technologies to help meet the needs of engines expected to be introduced into service in the 1980-85 time frame. The program is specifically aimed at accelerating the transfer of at least five materials technologies from the laboratory-feasibility stage to engine-demonstration testing. This will be done through scale up of selected materials technologies to allow the reliable manufacture and rig-testing of engine components and the subsequent verification of their potential performance improvements in ground-based engine tests. Cost/benefit and risk analyses are conducted to help guide the selection of the best candidate materials. The program is conducted through contracts with the domestic aircraft turbine engine industry.

Materials and Structures Systems Technology

W80-70119 **510-54-13**
Langley Research Center, Hampton, Va.
INTEGRATED PROGRAMS FOR AEROSPACE-VEHICLE DESIGN (IPAD)
R. E. Fulton 804-827-2887

Reduce vehicle design cycle time and design costs in the 1980's through development of components of a computer software system denoted IPAD for the total management of aerospace-vehicle design processes. System design and prototype software will demonstrate a 25% reduction in flow time for vehicle preliminary design tasks, a 50% reduction in man-hours to assemble engineering data for component design, and a 25% reduction in time and cost to generate engineering drawing data. The Industry Technical Advisory Board (ITAB) will review and critique development work and will be provided software components for evaluation and use as they are developed. Continued coordination will be maintained with the Air Force Integrated Computer Aided Manufacturing (ICAM) program to maximize benefits from the two programs.

W80-70120 **510-55-12**
Lewis Research Center, Cleveland, Ohio.
AEROELASTICITY OF TURBINE ENGINES
M. J. Hartmann 216-433-6906

The aeroelastic program is directed toward improving flutter boundary design criteria so that the occurrence of flutter in fans and compressors for advanced propulsion systems is essentially avoided. If flutter is encountered these criteria may also be used to expeditiously clear flutter from the operating region. The program will also provide, through analytical and experimental research, a more fundamental basis for reliable analysis, prediction, and thus the avoidance of instability regions. Analytical methods and computer codes will be developed to predict the unsteady aerodynamic forces under various flutter conditions, and to calculate the structural modes of blades, shrouds and disks as utilized in fans and compressors for advanced engines. The unsteady aerodynamic analysis will be verified in cascades in which the blades are driven as if they are in flutter. The structural analysis will be verified in a vacuum spin rig and in vibration rigs. The coupling of the aerodynamic forces and structure will be verified in suitable instrumented experimental fans. The prediction methods will be further verified by application to realistic data such as that obtained in full-scale engine research programs. This aeroelastic program is the NASA portion of an interdependent and coordinated program involving LeRC and AFAPL. The effort involves inhouse projects, as well as contract research with aerospace companies, and grants to various universities.

Propulsion Systems Technology

W80-70121 **511-55-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED LOW EMISSION COMBUSTOR
D. A. Petrash 216-433-6860

The objective is to evolve lean, premixed, prevaporized combustion technology into a practical aircraft gas turbine engine combustion system that exhibits superior performance, high durability, and environmentally acceptable pollutant emissions over the entire flight envelope. Special emphasis will be placed on achieving very low (< 3g NO2/kg fuel burned) oxides of nitrogen (NOx) emissions at stratospheric cruise conditions. NOx emissions will be reduced by operating the combustion systems at extremely lean fuel-air mixtures. Initially, fundamental inhouse, grant, and contract studies examine practical problems associated with this technique. Studies will be conducted to examine NOx production in lean combustion systems, flashback and autoignition limits, fuel preparation and stability augmentation techniques, and combustor constraints imposed by the engine. With the design information from the initial studies, combustor concepts will be integrated into engine system designs and assessed. Concepts which show potential for achieving program goals will be tested and screened. The most promising designs will be refined through component tests leading to an engine verification. If resultant optimized concepts cannot be incorporated into an existing engine, a preliminary engine design compatible with the combustor will be developed.

W80-70122 **511-58-12**
Lewis Research Center, Cleveland, Ohio.
HELICOPTER TRANSMISSION SYSTEM TECHNOLOGY
E. V. Zaretsky 216-433-6101

The objectives of this work are: (1) to demonstrate improvements in weight, noise, reliability, maintenance cost and size of helicopter transmissions; (2) to demonstrate compactness, reduced noise and reliability characteristics of hybrid traction drive systems; and (3) to demonstrate transmission life increase of 200 percent with conventional drive systems through the application of advanced technology power transfer components.

W80-70123 **511-59-12**
Lewis Research Center, Cleveland, Ohio.
BROAD SPECIFICATION FUELS TECHNOLOGY
J. Grobman 216-433-6229

The objectives of this effort are to evolve and demonstrate the technology required to utilize broad specification fuels in current and next generation commercial jet aircraft. The intention of this project is to extend the current R&T base Fuels Research Program to an integrated component investigation resulting in engine verification tests. The engines to be selected will be suitable and available advanced high-bypass ratio turbofan engines and will preferably incorporate the latest E(3) and Clean Combustor technology. The effort will be conducted through multiphase contracts using two parallel contractors throughout the length of the project. The technical conduct of this project effort will be similar to the multiphase approach used in the NASA Experimental Clean Combustor Program. The multiphase contract effort will consist of three consecutive phases which will systematically screen out the more promising combustor and fuel system concepts for using broad specification fuels, evolve these concepts into component hardware which is compatible with an existing engine, and actual verification tests to document engine performance and durability.

Avionics and Flight Controls Systems Technology

W80-70124 **512-51-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
DIGITAL FLY-BY-WIRE FLIGHT EXPERIMENT
C. R. Jarvis 805-258-3311

The overall objective of this effort is to provide the technology necessary for the implementation of advanced, reliable digital fly by wire systems in future aircraft. The program involves the development and demonstration of a unique flight test facility and its use in carrying out experiments to exploit state-of-the-art advancements is carrying out experiments to exploit-state-of-the-art advancements in digital technology. The facility allows flight test evaluation, in an operational environment, of unique advanced control law concepts, failure management techniques and operational procedures. Present activity is directed toward evaluation of innovative failure management techniques which take advantage of the increased computational capability of digital systems in achieving a higher degree of system reliability and integrity.

W80-70125 **512-54-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED GUIDANCE AND CONTROL SYSTEMS: VALIDATION TECHNOLOGY
C. T. Snyder 415-965-5567

The objective of this RTOP is to provide a data base for the design and validation of advanced navigation, guidance, and

control systems. The RTOP includes three programs: (1) a joint NASA/FAA program entitled 'Simulation Methods for the Validation of Digital Flight Control Systems (DFCS)', (2) 'A Ring Laser Gyro Tetrad Redundancy Management and Navigation Study', and (3) 'An Integrated Guidance and Autonomous Navigation System'. The objectives of the first program are to evaluate current DFCS validation technology, improve the government's understanding of this technology, and assess the cost effectiveness of advanced automated DFCS validation tools. The approach consists of laboratory and simulation investigations using a state-of-the-art DFCS to evaluate and improve control system (including software) validation techniques, augmented by industry surveys of present DFCS validation methods. The objectives and approach of the laser gyro strapdown tetrad system include the evaluation of tetrad redundancy management and navigation performance using motion simulation tests. Failure detection and identification techniques and anti-aliasing digital sampling filters will be evaluated using tetrad sensor data derived from UH-1H flight tests. The objective and approach of the third program are to fabricate and evaluate the performance of a new concept for providing navigation information from low cost gyros and conventional heading sensors.

W80-70126 **512-54-13**
Langley Research Center, Hampton, Va.
ADVANCED GUIDANCE AND CONTROL SYSTEMS: VALIDATION
Billy L. Dove 804-827-3681

Fault tolerant integrated digital avionic systems will have need for more thorough laboratory analyses than previous generations of avionics to generate the understanding of a new technology, provide insight into complex redundancy management schemes, and create an experience data base upon which all future aircraft system designs can be based. A special analysis tool--the diagnostic emulator is required for this analysis task, but does not exist presently with the needed capabilities, such as the rapid redefinition of designs for making modifications, and the controlled insertion of faults. A diagnostic emulator will be developed for analyzing the performance, reliability, and safety of fault tolerant systems. This effort is identified in the FAA-AIFS (Advance Integrated Flight System) Committee program plan.

W80-70127 **512-55-11**
Ames Research Center, Moffett Field, Calif.
HUMAN FACTORS IN AVIATION SAFETY
H. P. Klein 415-965-5094

This research is designed to identify factors which contribute to or cause human error in the aviation system, and to explore methods to prevent human error accidents by eliminating human error or by minimizing the adverse impact of such error when they occur. Descriptive studies of the aviation safety reporting system data base are used to determine system factors associated with human error, and to identify potential solutions to the human error problems so identified.

Aerodynamic Vehicle Systems Technology

W80-70128 **514-52-13**
Langley Research Center, Hampton, Va.
WAKE VORTEX MINIMIZATION
A. W. Hall 804-827-3274

The objective of this effort is to reduce the hazard potential of wake vortices shed by transport aircraft through aerodynamic means without significant detrimental effects on aircraft performance. This objective will be met by developing experimental techniques and theoretical numerical methods to enhance the understanding of the fundamental flow mechanisms associated with the generation of multiple vortex wakes, their interaction, and turbulent decay. A detailed understanding of the relationship of aircraft span-load distribution and turbulence effects will be obtained.

W80-70129 **514-52-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
WAKE VORTEX MINIMIZATION FLIGHT EXPERIMENTS
M. R. Barber 805-258-3311

This RTOP covers a cleanup of DFRC activities related to full-scale flight-test evaluations of various aerodynamic wake vortex alleviation devices. These devices have been, and/or, are being developed in ground facility tests at ARC and LaRC. The approach taken is that of flying the devices on actual transport aircraft (e.g., 747's, DC-10's, L-1011's, etc.). Comparisons of the vortex characteristics with and without the devices are made by probing the aircraft's wake with specially instrumented probe aircraft (e.g., DFRC's T-37, and the FAA's DC-9). To facilitate wake probing specialized vortex visualization systems have been developed and used.

Aeronautical Systems Studies

W80-70130 **530-01-13**
Langley Research Center, Hampton, Va.
GENERAL AVIATION SYSTEM TECHNOLOGY STUDIES
R. J. Tapscott 804-827-3216

The objective of this work is to undertake studies to evaluate missions and aircraft design concepts in order to identify the technology requirements for increased performance, productivity, and safety of general aviation aircraft. These studies will identify the design and operational systems requirements, and attendant costs and benefits, for existing as well as for future general aviation aircraft missions.

W80-70131 **530-02-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED ROTORCRAFT CONCEPTUAL AND TECHNOLOGY ASSESSMENT STUDIES
J. V. Christensen 415-965-6569

The objective of this effort is to investigate advanced concepts in rotorcraft configurations and technology which offer performance and operational advantages for civil applications. Advanced technology concepts for solution of rotorcraft problem areas (such as vibration, noise, safety, and gust response, etc.) and for improved future mission capabilities, will be evaluated with emphasis on vehicle configurations. Near term concepts assessments will focus on high reliability propulsion system concepts with integrated envelope monitoring, IFR guidance, navigation and control, and benefits/risks assessments of active control, fly-by-wire/fly-by-light to civil rotorcraft, based on study results completed under 514-50-01. Additionally, the benefits/risks and technology requirements for integrated advanced configuration/systems designs applicable to the next generation of corporate/business transportation, agriculture and public service rotorcraft will be identified and assessed. Far-term configuration technology assessments will concentrate on indepth design assessments of the most promising high productivity (cost effective) configurations/systems identified through studies under 791-40-31. The results of these studies will provide data and identify promising research options for incorporation into long-range NASA rotorcraft programs and plans.

W80-70132 **530-02-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED ROTORCRAFT SYSTEMS STUDIES
J. V. Christensen 415-965-6569

The general objective is to assess the civil mission requirements, growth patterns, markets, foreign competition, productivity criteria and national needs/benefits of importance in the definition and advocacy of an integrated agency programs in rotorcraft and related technology. Specifically the following areas will be assessed both in-house and under contract, as appropriate, with emphasis on the identification of NASA research options and the assessment of key technology benefits/needs: (1) far-term high productivity (cost effective) rotorcraft vehicle concepts (such as stopped rotor tilt rotor, large passenger/cargo, etc) criteria, benefits, needs and operational analysis; (2) agriculture/forestry

rotorcraft technology benefits/needs; (3) buoyant quadrotor; (4) rotorcraft markets and impact of foreign technology; (5) public service rotorcraft benefits/needs; (6) civil helicopter wire strike scenarios/factors; and (7) external lift rotorcraft mission requirements/benefits assessment.

W80-70133 **530-02-18**
Wallops Station, Wallops Island, Va.
AIRBORNE EXPERIMENT PLATFORMS
H. C. Needleman 804-824-3411

This study effort is directed toward establishing the utility and technology requirements of two classes of unmanned airborne experiment platforms - high altitude powered platforms, including heavier-than-air and lighter-than-air vehicles, and unpowered platforms, including tethered and mid-air-deployed balloon borne platforms - for use by the scientific and applications experimenter community as tools to complement existing research techniques. User applications, mission concepts, and system concepts will be investigated with emphasis on high altitude and deployment operations, compatibility with science user requirements, and system integration.

W80-70134 **530-04-12**
Lewis Research Center, Cleveland, Ohio.
PROPULSION SYSTEMS FOR SMALL TRANSPORTS
R. J. Weber 216-433-4000

This RTOP covers the propulsion efforts at Lewis in support of the small transport advanced technology (STAT) program led by the Ames Research Center. Studies are performed to identify engine designs suitable for commuter aircraft. Component research is carried out to advance the various technologies that are found to be required.

W80-70135 **530-05-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED PROPULSION SYSTEM CONCEPTS
R. J. Weber 216-433-4000

Studies will be performed of engine cycles, complete propulsion systems, and integrated engine/airframe combinations applied to representative airplane missions. The object of the studies is to determine desirable engine component and system design characteristics for future aircraft and to identify technology deficiencies and profitable areas for research. The studies will explore the opportunities for satisfying environmental and natural resource constraints and their related impact on propulsion system selection and aircraft performance.

W80-70136 **530-06-17**
Lyndon B. Johnson Space Center, Houston, Tex.
INTEGRATED ELECTRICAL/ELECTRONIC CONTROL SYSTEMS STUDY
R. C. Kennedy 713-483-4281

It is the objective of this RTOP to determine the applicability of new electrical, mechanical, and electronic technologies exposed in the course of the space shuttle development to aeronautics, with initial emphasis on civil air transport. Determinations will be made as to what steps are necessary to effect the technology transfer or alternately, what additional technology is needed before the transfer can be realized. Digital atmospheric flight control, multiplexed data transmission for command and control, and software monitoring and management of vehicle systems have been flight demonstrated during the orbiter approach and landing tests. Also, the Johnson Space Center has completed the technology development of an electromechanical flight control actuator which uses a high voltage d.c. source and is sized to orbiter requirements. These technologies, as applied to various classes of commercial transports, will be analyzed and traded to determine if their use offers a potential for reducing aircraft acquisition and operational costs and/or increases overall aircraft productivity. Both all new and derivative aircraft will be studied.

General Aviation Systems Technology

W80-70137 **531-01-11**
Ames Research Center, Moffett Field, Calif.
GENERAL AVIATION ADVANCED AVIONICS SYSTEMS
B. Y. Creer 415-965-5438

The objective of this program is the design and demonstration of a totally integrated advanced, low-cost avionics system to enhance the safety, reliability, and utility of future general aviation aircraft. The approach is to synthesize various subsystem concepts and conduct supporting studies of the projected microelectronic and fluidic technology, aircraft design, and air traffic control environment of the 1980's, to formulate a system definition which can be scrutinized against requirements and cost-benefit criteria to formulate final specifications and designs. The system design will be verified in simulations and flight tests with active participation of the FAA and the aviation industry. This is a joint program between ARC and LaRC. The lead center is ARC who, in addition to subsystems development, is responsible for the overall final system design, fabrication, simulations and flight tests. LaRC is responsible for the development of fluidic and other avionic subsystems with emphasis directed towards the light aircraft end of the general aviation spectrum.

Low-Speed Systems Technology

W80-70138 **532-01-11**
Ames Research Center, Moffett Field, Calif.
HELICOPTER AND ADVANCED ROTORCRAFT OPERATING SYSTEMS EXPERIMENTS
B. Y. Creer 415-965-5430

The objective of this research is to provide the critical technology to allow rotorcraft operating under Instrument Meteorological Conditions (IMC) to have operating performance comparable to performance under Visual Meteorological Conditions (VMC). The research program will be based on needs, requirements and operating experience of the users, in coordination with the FAA and industry. Systems concepts will be defined, constructed and evaluated through simulations, controlled flight research under highly instrumented conditions and operational flight assessments. There are three main all-weather rotorcraft system technology thrusts. These are (1) remote sites 'on-board' systems technology, (2) navigation and guidance concepts and operating systems research for operations into high density terminal areas and integrated Category III systems and (3) investigations of XV-15 advanced rotorcraft operating systems. 'On-board' systems technology will be developed and validated for IMC approach guidance and navigation to off-shore and on-shore remote sites. Guidance and navigation concepts and operational procedures will be investigated that allow use of airspace separate from that used by CTOL traffic. Emphasis will be on the exploration and development of concepts that will allow rotorcraft to operate IFR with the same utility and flexibility that they currently have under VFR.

W80-70139 **532-02-11**
Ames Research Center, Moffett Field, Calif.
QUIET PROPULSIVE-LIFT TECHNOLOGY EXPERIMENTS - AIRCRAFT PERFORMANCE AND OPERATING SYSTEMS RESEARCH
L. Roberts 415-965-5486

This program will furnish the U. S. Government and aircraft industry with flight data to develop certification criteria and design methods for civil propulsive-lift short-haul transports. It will take maximum advantage of civil-military STOL/RTOL transport commonality. The program will develop advanced technology for propulsive-lift shorthaul transport applications which will benefit civil derivatives of the AMST, future generation military STOL transports, and future civil propulsive-lift R/STOL transports. Broad flight experiment areas involve (a) correlation of methods for predicting vehicle characteristics with flight-measured characteristics, (b) studies of flight control systems, cockpit displays, and

navigation system requirements for STOL/RTOL terminal area flight operations. These experiments will be conducted through a complementary flight test program using the Quiet Short-Haul Research Aircraft (QSRA) Augmentor Wing Jet STOL Research Aircraft, and the AMST aircraft. A small part of the QPLT effort includes ground-based technological efforts to support and/or complement flight activities. Most of the flight experiments will be conducted on the QSRA, with the approach being to utilize the QSRA as a national propulsive-lift flight facility.

W80-70140 **532-02-12**
Lewis Research Center, Cleveland, Ohio.
QPLT SYSTEMS TECHNOLOGY
M. F. Valerino 216-433-4000

This RTOP provides for Lewis Research Center participation in the NASA Quiet Propulsive Lift Technology (QPLT) Experiments Program which includes flight research experiments in the areas of propulsion system performance and noise to be conducted using the NASA Quiet Short-Haul Research Aircraft (QSRA). Emphasis will be on propulsion acoustics, including measurements of effects of forward velocity and of the QSRA O.T.W. engine configuration on the farfield noise characteristics. The flight measurements will be made through a cooperative effort with Ames Research Center. In addition, continuing QSRA propulsion support will be provided.

W80-70141 **532-03-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED ROTOR SYSTEMS TECHNOLOGY/RSRA OPERATIONS
Samual White, Jr. 415-965-6566

The objective of this systems technology program is to provide and validate integrated rotor system technology required to substantially improve the performance, utility, efficiency, dynamics noise, maintainability and ownership cost of civil and military helicopters through system design studies, focused small and large scale tests in ground-based facilities, and selected flight tests of current state of the art rotors and advanced concept rotor systems. The goals of this program are to: advance the aerodynamics and structural dynamics technology of rotor blades to increase performance and efficiency, to reduce noise, vibration, weight/cost, and control system requirements; improve rotorcraft gust response and flight control/stability characteristics through utilization of active rotor control and composite construction technologies; expand the ground based facility data base on rotors of opportunity, and on a family of new blades having systematic vibrations in aero-dynamic design parameters; expand the flight data base on existing rotors that can be readily adapted for evaluation on RSRA (and other test rotorcraft); develop and evaluate in ground-based facilities one advanced research rotor which is flightworthy for subsequent flight test on RSRA; expand the design criteria for rotor and rotor control systems to improve rotorcraft handling qualities through high fidelity moving-base simulations

W80-70142 **532-04-11**
Ames Research Center, Moffett Field, Calif.
TILT ROTOR RESEARCH AIRCRAFT FLIGHT INVESTIGATIONS
D. D. Few 415-965-5445

For several years,the NASA and the Army have been engaged in a joint effort to advance the technology of tilt rotor V/STOL aircraft. The significant ongoing effort is the NASA/Army XV-15 tilt rotor research aircraft (TRRA) project. The project has completed its major ground and wind tunnel tests. Airworthiness flight tests are scheduled for 1979, followed by the government proof-of-concept (POC) flight tests scheduled to be completed in 1980. Completion of the POC flight tests will satisfy the objectives of the current project, namely, verify rotor/pylon/wing dynamic stability and performance, establish a safe operating envelope, assess handling qualities, investigate gust sensitivity, and investigate the effect of disk loading and tip speed on downwash and noise in hover mode. The goal of this flight investigation program is to provide the U. S. aircraft community the design criteria and operational data required for the development, certification and operation of tilt rotor V/STOL aircraft with low technical risk. This will be accomplished by completing the government proof-of-concept testing at Dryden, as noted above, and then conducting flight tests of military and civil mission profiles, near terminal operations and detailed handling qualities evaluations at Ames. Also at Ames, flight experiments involving automatic landing and guidance and navigation will be conducted. Studies will be conducted in areas where new technology holds promise for significant payoff when applied to tilt rotor aircraft. Fabrication and test of the flight type hardware for wind tunnel testing will be accomplished.

W80-70143 **532-04-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT TEST OF THE TILT ROTOR RESEARCH AIRCRAFT
W. D. Painter 805-258-3311

This RTOP covers Dryden Flight Research Center (DFRC) support to Ames Research Center (ARC) for the flight test of the tilt rotor research aircraft (TRRA) program. DFRC will support a joint flight-test team with Flight Operations and Support and Engineering directorates as needed to successfully complete the flight-test program. This plan covers the conduct of all proof-of-concept flight testing of the XV-15 Tilt Rotor Research Aircraft at DFRC considering the overall technical objectives, manpower, funding and program schedules.

W80-70144 **532-05-11**
Ames Research Center, Moffett Field, Calif.
VTOL SYSTEMS TECHNOLOGY
L. Roberts 415-965-6373

The objective of this RTOP, which is a companion to RTOP 505-10-31, is to provide the systems technology required to enable the development of military and civil aircraft having VTOL capability and viable mission performance. Theoretical and experimental configuration-dependent technology development will be undertaken in the areas of highspeed aerodynamics, low-speed aerodynamics, and flight dynamics. Critical areas of aerodynamic uncertainty are being identified to guide future research efforts. To insure that all major high-speed propulsion system/airframe interactions are accounted for properly, compact propulsion simulators will be incorporated into the high-speed scale-model experimental investigations of potential VTOL configurations. Low-speed aerodynamic research will concentrate on the aerodynamic characteristics of high performance, powered-lift configurations, development of high performance augmentors for VTOL application, and providing design criteria for the development of VTOL nacelles and pneumatic power transfer systems. Flight control system and display requirements will be investigated for specific configurations primarily through piloted simulation. NASA will also provide, under this RTOP, technical support for Navy-funded efforts to develop VTOL aircraft technology applicable to specific future Navy mission needs.

W80-70145 **532-05-12**
Lewis Research Center, Cleveland, Ohio.
VTOL PROPULSION SYSTEMS TECHNOLOGY
Carl C. Ciepluch 216-433-6644

The development of viable military and civil aircraft having vertical-takeoff-and-landing (VTOL) capability in addition to performance capabilities approaching those of current operational aircraft (CTOL) requires the development of additional propulsion system technology. Propulsion industry contractors will be selected to extend mathematical modeling and simulation technology to cover new VTOL propulsion components. System architecture studies will be conducted by competitively selected teams consisting of aircraft, propulsion, and digital system companies. Key technology programs will be undertaken by NASA to support VTOL propulsion development using funds provided by the Navy. The programs will be outlined in the joint Navy/NASA document formalizing the work. The program includes aerodynamic testing of fans, inlets, thrust deflectors, ejectors, and thrust control devices.

High-Speed Systems Technology

W80-70146 **533-01-11**
Ames Research Center, Moffett Field, Calif.
FUEL TANK SEALANTS
R. W. Rosser 415-965-5244

Fuel tank sealants will be developed which offer improved service life under conditions encountered in advanced supersonic aircraft when compared to state-of-the-art materials. The specific objective is to obtain pilot plant quantities of characterized and useful sealant materials for flight test evaluation. The goal will be accomplished through a series of steps as follows: produce a fluoroether dinitrile prepolymer in 10-20 lb. range; chain extend the prepolymer into a heterocyclic-fluoroether gum stock and develop a process for its manufacture; select a suitable and adequate crosslinking system for the gum stock; compound the gum stock into a useful material which will afford mechanical properties suited to a fillet seal application; and apply the fluoroether sealant material to flight simulation studies and develop a performance specification from actual flight tests.

W80-70147 **533-01-13**
Langley Research Center, Hampton, Va.
SCR-MATERIALS AND STRUCTURES
E. E. Mathauser 804-827-2036

The objective is to establish a supersonic materials and structures technology base by developing capability in structural concepts and design, loads and aeroelasticity, materials fatigue and manufacturing methods. The development of capability for computer aided analysis and synthesis will be undertaken, and validation of the computer design tools and methodology by applications to supersonic cruise configurations will be made. Advanced transonic/supersonic aeroelastic load prediction methods will be developed and a description of high altitude atmospheric turbulence environment obtained. Included also is work on strength, fatigue and fracture to establish structural integrity of materials and representative components; application of advanced resins and adhesives and performance of time-temperature-stress studies of composites; and development of fabrication methods for composites and titanium with emphasis on superplastic forming. The technology from this program will permit major reductions in structural weight, improved structural integrity, and lower cost for supersonic cruise aircraft.

W80-70148 **533-01-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
SCR MATERIALS AND STRUCTURES FLIGHT RESEARCH
B. M. Kock 805-258-5311

The objective of this activity is to advance the technology related to structural materials suitable for high speed cruise and/or high temperature applications. Airframe component parts will be manufactured, laboratory tested and installed on airplanes for flight validation. Components will be manufactured of both metallic and composite materials.

W80-70149 **533-01-32**
Lewis Research Center, Cleveland, Ohio.
SCR PROPULSION TECHNOLOGY
R. M. Weber 216-433-4000

Advances in propulsion system technology will be required to permit the development of a quiet, clean, economical commercial supersonic transport. Contracts for the study of such airplanes have been let by Langley Research Center, and other supporting work is being performed at each of the NASA Research Centers. As part of that effort, LeRC is studying the propulsion system in order to define the most desirable engine cycle, identify technology requirements, and advance the various component disciplines peculiar to supersonic flight to the point where development of an actual engine could be undertaken when desired. The effort involves in-house and contracted research in engine cycles, noise and pollution, stability and control, materials, and various unique components.

W80-70150 **533-01-43**
Langley Research Center, Hampton, Va.
SCA - AERODYNAMIC PERFORMANCE TECHNOLOGY
V. R. Mascitti 804-827-4576

The objectives of this program are to advance the state of the art in supersonic aerodynamics through the generation of comprehensive data bases on promising advanced supersonic configuration concepts, through the development of better tools for aerodynamic design and analysis, and through continued research on important sonic boom phenomena. Aerodynamic advances resulting from this program will be studied in concert with technology advances in the related disciplinary areas of propulsion, structures and materials and controls through detailed technology integration studies of representative supersonic cruise aircraft concepts. Throughout the studies, major consideration will be given to the factors which influence and improve the noise, sonic boom, energy efficiency, and overall performance of potential future supersonic cruise aircraft. Objectives of the program will be accomplished through construction and tests of models of industry and NASA supersonic cruise concepts, through support of in house, industry and university approaches to the development of new design and analysis methods, and through in-house configuration studies of sonic boom. Inhouse NASA and industry technology integration teams will assess the applicability and potential payoff of advanced supersonic technology to an adequate depth to provide reliable direction to the future research effort. Where possible, the basic researcher and industry teams will work closely together on the difficult technical problems of supersonic flight.

W80-70151 **533-01-62**
Lewis Research Center, Cleveland, Ohio.
PROPULSION SYSTEM/AIRFRAME INTEGRATION TECHNOLOGY
D. N. Bowditch 216-433-6123

Inlet engine airframe integration design methods will be generated which will allow the optimization of the SCR inlet/VCE engine propulsion systems and their mutual interactions with the SCR airframes. Inlet type-VCE engine cycle matching and optimization studies will be conducted both in-house and on contract to the SCR & VCE contractors. Subscale experimental inlet data will be obtained for candidate inlet types over the full aircraft speed range from brake release to supersonic cruise. Inlet/wing intergration data will also be obtained with these models. The results of the studies and subscale tests will be used to guide the design of a full scale inlet to match and the testbed VCE. The full scale inlet/engine system (including stability and control systems) will be tested over the full speed range.

W80-70152 **533-01-63**
Langley Research Center, Hampton, Va.
SCR - AIRFRAME/PROPULSION SYSTEM INTERACTIONS
V. R. Mascitti 804-827-4576

Model variable cycle engines have been defined in previous SCAR supported studies for possible application to commercial supersonic transport aircraft. The extended flow variability made possible by such engines require greater versatility of the inlet and exhaust nozzle than for conventional engines. The range of flexibility of all propulsion system components need to be defined such as to maximize internal thrust and minimize nacelle and interference drag throughout the flight regime. A part of the SCAR program, a study of the integration problem of the propulsion system will be made to identify technology requirements and advance the various component disciples to the point where intelligent choices can be made. The effort involves inhouse and contracted research on isolated inlets and nozzles as well as the mutual installation effects on complete airplane configurations. This effort will be a cooperative and coordinated endeavor of both Langley and Lewis Research Center.

W80-70153 **533-02-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED FIGHTER TECHNOLOGY INTEGRATION/F-111 (AFTI/F-111)
L. J. Caw 805-258-3311

The objective of this program is to conduct a series of flight

experiments. Dryden Flight Research Center will operate an F-111 aircraft and conduct an investigation of the Mission Adaptive Wing (MAW) as a part of the joint NASA-Air Force AFTI-111 Program. Dryden will participate in design reviews, develop and operate instrumentation and define flight test plans.

W80-70154 **533-02-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
F-14 HIGH ANGLE-OF-ATTACK
H. L. Smith 805-258-3311

The objective of this project is to conduct a flight test utilizing the Langley Research Center developed aileron-rudder interconnect system to imrpove control at high angle-of-attack on the F-14 aircraft. The system will be flight tested by Dryden Flight Research Center jointly with the Navy and Langley Research Center.

W80-70155 **533-02-44**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
INTEGRATED RESEARCH AIRCRAFT CONTROL TECHNOLOGY
Berwin M. Kock 805-258-3311

The goals of the project are to develop and validate design processes for digital integrated propulsion and airframe control systems; to develop and demonstrate digital engine controls that improve performance, safety, and life cycle costs; and to demonstrate airplane performance improvements using multivariable/integrated control techniques. A research aircraft will be modified to incorporate a control system capable of supporting these goals. Software will be developed to achieve the integration of airframe and propulsion systems. A flight research phase will demonstrate and validate the performance benefits derived from the integration process.

W80-70156 **533-03-13**
Langley Research Center, Hampton, Va.
HIGHLY MANEUVERING AIRCRAFT TECHNOLOGY
W. P. Henderson 804-827-2676

The objective of this research is to promote and stimulate the application of new and innovative technologies in a multidisciplinary manner so as to exploit, to the highest practical degree, the synergistic potential of the new technologies for the design of future fighter aircraft. A vital part of this research will be to support the ongoing NASA HiMAT programs. The study of the highly integrated canard-wing concept will be pursued with the objectives of defining the stability and control characteristics at high angles of attack. Promising ideas for obtaining high aerodynamic performance for maneuvering fighter aircraft will be examined analytically and experimentally with primary emphasis on investigating their aerodynamic performance, propulsion, stability, and control characteristics. Representative promising concepts which will be incorporated into the basic canard-wing concept include a high aspect ratio, two dimensional, vectoring nozzles utilized to enhance the maneuvering performance of the aircraft or to provide control forces such that the large radar reflection control surfaces can be eliminated and anti-spin devices. The experimental studies will be conducted in the Langley 16-foot, full-scale and spin tunnels, and simulator studies in the Differential Maneuvering Simulator (DMS).

W80-70157 **533-03-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY FLIGHT RESEARCH
P. C. Loschke 805-258-3311

This RTOP covers the flight test phase of a program to provide improved technology for the design of highly maneuverable aircraft. Present design restraints will be relaxed to permit complete freedom in the application of state-of-the-art systems such as integrated, computerized controls, composite structures, propulsion augmentation of lift and control, and the like, in order to achieve maximum benefits from synergistic effects. The complex and innovative configurations such as the HiMAT design can only be validated and the high risk technology matured for manned vehicle application through extensive testing of the complete configuration in the real and dynamic environment of flight. The high level of technical risk inherent in the HiMAT designs precludes their application to manned prototype vehicles because of pilot safety concerns and the enormous cost of these aircraft. This program will use large scale free flying models controlled by remote piloting techniques to acquire actual flight test data at a minimum cost. The facility for these tests exists at DFRC and is currently being extended to handle supersonic vehicles.

Transport Aircraft Systems Technology

W80-70158 **534-01-13**
Langley Research Center, Hampton, Va.
LAMINAR FLOW CONTROL
R. J. Muraca 804-827-2045

The broad objective of this laminar flow control (LFC) element of the NASA aircraft energy efficiency (ACEE) program is to develop and demonstrate a practical, reliable, maintainable laminar flow control system for viscous drag reduction of future commercial transport aircraft. The technology developed will be applicable to, although insufficient for, military transports. The LFC element of ACEE consists of four separate but related phases: (1) definition of candidate LFC system concepts for application to future production aircraft; (2) initial development and limited evaluation of selected LFC subsystems, and development and limited evaluation of selected LFC system concepts and design, fabrication and flight demonstration of integrated LFC systems in a validator aircraft. The phase 1 effort was concluded in September of 1978. The phase 2 activities, which will be accomplished in fiscal years 1979 through 1982, are covered by this RTOP.

W80-70159 **534-01-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
LAMINAR FLOW CONTROL FLIGHT RESEARCH
T. R. Sisk 805-258-3311

The overall objective is to improve the aerodynamic efficiency of cruise aircraft through viscous drag reduction by maintaining laminar flow over significant portions of an aircraft's lifting surfaces. The LFC research will determine the practical incremental reduction in drag achievable with distributed boundary layer suction. These drag reductions and subsequent energy efficiency will be evaluated in relation to the weight, complexity, and power requirements of the suction system and the impact on aircraft design.

W80-70160 **534-02-11**
Ames Research Center, Moffett Field, Calif.
ENERGY EFFICIENT TRANSPORT WIND TUNNEL TESTING
Richard H. Petersen 415-965-5851

Technical assistance, consultive services and support, through the use of NASA-Ames facilities, will be provided to NASA Langley for the Energy Efficient Transport Project (EET). Support tests will be primarily conducted in the Ames 11- by 11-foot Transonic and 12-foot Pressure Wind Tunnels.

W80-70161 **534-02-13**
Langley Research Center, Hampton, Va.
ENERGY EFFICIENT TRANSPORT TECHNOLOGY
W. J. Alford 804-827-2396

The purpose of this activity is to expedite industry acceptance and application of advanced aerodynamics and active controls technology in an integrated manner to achieve significant energy, economic, and aircraft sales benefits. Inhouse and industry experimental and analytical efforts will be continued in the areas of supercritical aerodynamics, high lift systems, propulsion/ airframe integration, and wing/empennage/flight control systems. The industry activities are oriented both at near term derivative aircraft product improvements and farther term new aircraft development. The inhouse activities are generally focused on the longer term new generation aircraft technologies that have higher potential benefits with commensurately higher risks. Emphasis will be placed on techhnologies having the greatest benefits to long haul subsonic derivatives and new transport aircraft.

W80-70162 **534-02-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ENERGY EFFICIENT TRANSPORT FLIGHT RESEARCH
M. R. Barber 805-258-3311

Three separate elements are covered as follows: flight tests of Whitcomb Winglets on a KC-135 aircraft; development of system integration technique resulting in the design of an active control system that will provide gust alleviation, maneuver load control and flutter suppression for the Aeroelastic Research Wing Vehicle (ARW-2); and determination of the extent of natural laminar flow that can be obtained with promising consistency on a subsonic cruise airfoil designed for favorable pressure gradients.

W80-70163 **534-03-02**
Lewis Research Center, Cleveland, Ohio.
IMPROVED RESIN MATRIX COMPOSITES
T. T. Serafini 216-433-6179

The overall objective of this research is to develop composite materials which have the desirable high performance properties of polymer matrix/graphite fiber composites while eliminating the hazard to unprotected electrical equipment caused by graphite fiber release in fire related accidents. The program includes research and development efforts in two major areas: (1) synthesis of new and/or improved matrix resins, and (2) development of hybrid composites which exhibit improved of constituent materials when subjected to fire situations.

W80-70164 **534-03-03**
Langley Research Center, Hampton, Va.
ALTERNATE MATERIALS FOR STRUCTURAL COMPOSITES
R. T. Swann 804-827-2969

The objective of this program is to develop advanced composite materials with balanced combinations of properties which reduce the possible electrical hazard identified for carbon fibers and which correct current deficiencies in graphite reinforced polymer matrix composites to meet the needs of future CTOL aircraft. Research and development activity will be focused on new or modified matrix resins, and on hybrids. Generic CTOL applications will be evaluated in terms of basic materials, micromechanics, and structural considerations. An assessment, including industry participation, will be made of desirable and practical balances between carbon fiber risk, strength, fracture toughness, impact resistance, and environmental stability. Improved characterization methods, particularly for fracture toughness and impact resistance, will be developed and applied to screen new or modified materials and composites. Structural components will be fabricated and tested to validate these promising new composites. Consideration will be given in this validation activity to minimum release of electrically conducting fibers and to economic aspects of commercial production, as well as to structural performance.

W80-70165 **534-03-09**
Marshall Space Flight Center, Huntsville, Ala.
SiX Ny Cz FIBERS BY CONTROLLED PYROLYSIS OF NOVEL ORGANOSILICON POLYMERIC PRECURSORS
W. J. Patterson 205-453-3536

The fiber release problem associated with carbon and graphite composites can seriously perturb the advanced aerospace programs fed by this area of technology. The objective of this project is to develop silicon nitride/silicon carbide fibers from novel organosilicon polymeric precursors via conventional fiber pyrolysis techniques. It is expected that such fibers will approach the strength and modulus of graphite without the electrically hazardous high conductivity. The validity of this technical approach is supported by recent patent reports of high strength, high modulus SiC/Si3N4 pyrolytic fibers formed from organosilane polymeric precursors.

W80-70166 **534-03-11**
Ames Research Center, Moffett Field, Calif.
EVALUATION AND DEVELOPMENT OF ADVANCED STRUCTURAL COMPOSITE MATERIALS
J. A. Parker 415-965-5225

The primary objective of this RTOP is to develop and demonstrate a modified composite material which will solve the problem associated with state-of-the-art graphite composites. These problems are not only fiber release in post-crash fires, but also include flammability, environmental instability and thermal delamination. Specifically, the objective is to develop the equipment, facilities and procedures for laboratory and full-scale testing of modified composite materials and to design, synthesize, formulate and process a selected set of modified and new fibers and resins. The information that will be generated under this plan will be used to structure a data base and a mathematical model of the materials which will permit a more rapid and reliable prediction of the performance of new composites. The intent of developing this model is to significantly reduce the cost, time and amount of data required to validate the properties of new materials and thereby insure their rapid application by industry. This is a cooperative effort involving several agencies including DOT, DOD and other NASA Centers.

W80-70167 **534-03-13**
Langley Research Center, Hampton, Va.
COMPOSITE COMPONENTS TECHNOLOGY
L. F. Vosteen 804-827-3081

The objective of the composite components is to accelerate the introduction of composite structures in commercial transport aircraft. This will be accomplished through the progressive introduction of selected components in current aircraft production. Design technology for typical secondary structure components and medium sized primary structures will be developed. Manufacturing processes suitable for production will be developed and verified through comprehensive ground testing.

W80-70168 **534-03-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CARBON FIBER TECHNOLOGY FOR ALLEVIATION OF ELECTRICAL HAZARDS
Kumar Ramohalli 213-354-7228

It is the objective to demonstrate practical solutions to the potential electrical hazards problem by means of techniques developed in FY78 and 79 based on small modifications to the state-of-the-art materials and production technology. In this program, aimed at developing safe carbon fiber composites, it is the objective to demonstrate that the fiber catalytic gasification scheme develcped at JPL is directly applicable to composite structures in a typical fire situation. The proven catalysts and synergistic combinations of them will be included in the composites. The treatment of fibers and woven fabrics will consist of coatings, inercalation and inclusion in the sizing, prepreg chemical or the main resin. Tests will be conducted to determine the retention of the catalyst in the composite material under different conditions of ambient temperature, humidity, and stress. Properties of interest in the studies on composite materials include thermal degradation, pyrolysis, service life, mechanical properties, processibility and cost. Concurrently, a small level of effort will be devoted towards a fundamental modeling study to enhance our understanding and to suggest economical methods towards the final solution. The concept used to develop the fiber detection apparatus under separate NASA LaRC sponsorship in FY79 will be employed to evaluate the improved composites. The university contract will be continued (at a small level in FY79) to draw upon the vast fundamental knowledge gathered in carbon related areas.

W80-70169 **534-03-23**
Langley Research Center, Hampton, Va.
BEHAVIOR OF ADVANCED COMPOSITES IN AIRCRAFT ACCCIDENTS
R. J. Huston 804-827-2851

The objectiva of this program is to determine the risk associated with the accidental release and dissemination into the atmosphere of carbon fibers from composite materials upon the crash and burning of civilian aircraft. The amount and type of carbon fibers released from various types of aircraft parts will be determined. Studies of fire plumes will be conducted so that an algorithm will be available to model the wide range of possible aircraft fire situations. The lifetime and degradation of

deposited carbon fibers will be studied to establish the likelihood and extent of redissemination of fibers from various natural environments. Experimental studies of various fiber transfer factors, such as filter systems, building containment, and equipment packaging will be studied experimentally to establish the effectiveness of such methods in limiting fiber access to sennsitive equipment components. The damage susceptibility of many types of electrical/electronic equipment to carbon fiber exposure will be studied experimentally and analytically. Several risk assessment methodologies will be used to assess risk using the constituent source, dissemination, transfer, and vulnerability factors. Large scale outdoor testing involving the actual release of fibers from a simulated aircraft crash and fire will be conducted for verification of the amount and type of fibers released from typical aircraft structural components.

W80-70170 **534-04-13**
Langley Research Center, Hampton, Va.
TERMINAL CONFIGURED VEHICLE PROGRAM
J. E. Stitt 804-827-3745

The Terminal Configured Vehicle (TCV) Program is an advanced technology activity focused on conventional take-off and landing (CTOL) transport aircraft that will be operating in reduced weather minima in the future high-density terminal areas equipped with new landing systems, navigation aids, and increased surveillance and automation under development by DOT/FAA. The broad objectives of the program are to provide improvements in the airborne systems (avionics and air vehicle) and operational flight procedures for reducing approach and landing accidents, reducing weather minima, increasing air traffic controller productivity and airport and airway capacity, saving fuel by more efficient terminal area operations, and reducing community noise by operational procedures. This involves research analyses, simulations, and flight studies. A modified Boeing 737 airplane, equipped with highly flexible display and control equipment made available by DOT/FAA, will be used to study operations in simulated future terminal area environments.

W80-70171 **534-05-11**
Ames Research Center, Moffett Field, Calif.
FIREMEN - FIRE RESISTANT MATERIALS
L. L. Fewell 415-965-5986
(505-08-21; 534-05-17)

The technological and engineering aspects of fire-resistant materials will be utilized for the design of aircraft passenger seats that are of a high level of fire resistivity. The objectives of this program are: (1) to develop and utilize the various technological and engineering aspects of fire-resistant materials in the design of aircraft passenger seats; (2) the simulation of a post crash fire event in the cabin fire simulator using a thermal flux of 12-15 W/sq cm; and (3) to evaluate the degree of fire resistivity by conducting full-scale burn tests of contemporary and improved fire resistant aircraft passenger seat assemblies.

W80-70172 **534-05-17**
Lyndon B. Johnson Space Center, Houston, Tex.
FIREMEN - FIRE SYSTEMS AND FULL SCALE TESTS
R. W. Bricker 713-483-3166

This RTOP consists of work originally started in FY-76 and continued through FY-79. It provides for development and testing of lightweight cargo bay liners; procurement of new fire retardant non-metallic materials; negotiation with a contractor to fabricate fuselage test sections, prepare the test site, and fit the 737 fuselage test areas with instrumentation and refurbishments as required; definition of toxicity testing techniques; procurement of necessary test instruments and associated materials; and performing inhouse component testing.

Advanced Propulsion Systems Technology

W80-70173 **535-01-12**
Lewis Research Center, Cleveland, Ohio.
ENERGY EFFICIENT ENGINE PROJECT
Neal T. Saunders 216-433-5594

The objective of this project is to develop and demonstrate technology for a next-generation turbofan engine having 10-15% lower specific fuel consumption, at least 5% reduction in direct operating cost, and reduced emissions and noise levels as compared to current high-bypass turbofan aircraft engines. Initial program efforts included preliminary engine design and integration studies through contracts with two aircraft engine manufacturers. On the basis of these studies and associated airframer and airline evaluations, engine cycles and configurations that best meet project goals were identified. The major part of the project was then initiated with award of parallel component development and integration contracts to the same two engine companies. These latter contracts emphasize the advancements in component and systems technologies required for possible future commercial development of more energy efficient engines. Advanced engine components are being designed and developed, and performance will be verified by rig tests. The high-spool core system will be designed, fabricated, and tested to evaluate its performance characteristics and to further refine the design of the components. The low-spool assembly will be integrated with the core to evaluate two-spool integrated performance and mechanical systems performance.

W80-70174 **535-02-12**
Lewis Research Center, Cleveland, Ohio.
VARIABLE CYCLE ENGINE COMPONENTS
Albert G. Powers 216-433-4000

Advanced supersonic transport aircraft are required to operate over a wide variety of flight conditions. This creates conflicting requirements on the propulsion system which, in many cases can be most effectively met by a variable cycle engine (VCE). A VCE typically has two or more distinct operating modes, each tailored to provide optimum efficiency at one of the major flight conditions, e.g., takeoff, subsonic cruise and supersonic cruise. The engine studies conducted under RTOP 517-53-32 have identified two VCE candidates of primary interest. These are the variable stream control engine (VSCE) and the double bypass engine (DBE). Both engines offer significant potential improvements over conventional engines in terms of both performance and environmental impact. Each depends, however, on the efficient functioning of novel and unique components including their compatibility with each other and with other engine subsystems when integrated into the selected engine configuration. It is the objective of this RTOP to generate the advanced component technology and component/integration data required in the most critical areas of candidate variable cycle engines (VCE) in order to demonstrate the feasibility and readiness of these component technologies required for supersonic cruise engines having high propulsive efficiency together with reduced noise and emissions.

W80-70175 **535-03-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED TURBOPROP - INSTALLATION AERODYNAMICS
Leonard Roberts 415-965-5889

The objective of this research is to support the development of the technology required to demonstrate the feasibility of advanced turboprop transport aircraft capable of cruise speeds and altitudes up to .8 Mach number and 35,000 ft. System studies will be conducted to analyze specific aircraft design tradeoffs. These studies will serve to determine the aircraft installation trades in terms of cruise speed, engine location, and propeller characteristics and thereby identify the most promising directions for future research. Through a combination of theoretical and experimental studies, the aerodynamic technology required to integrate advanced turboprop propulsion systems with transport aircraft using supercritical wing technology will be developed.

Detailed flow interactions among the propeller slipstream, nacelle, and wing surface will be examined and methods identified to optimize the installation. Theoretical analyses will include existing linear methods and the development of an advanced method capable of handling the transonic slipstream-nacelle-wing interaction. Experimentally, the flow interactions will be investigated using (1) a slipstream simulator to define the characteristics of the slipstream-supercritical wing interaction and, (2) a powered semispan model to provide an accurate simulation of the actual flow conditions.

W80-70176 **535-03-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED TURBOPROP TECHNOLOGY
James F. Dugan 216-433-4000

The objective of the Advanced Turboprop Program is to develop technology for efficient, reliable, and acceptable operation of advanced turboprop-powered aircraft at cruise conditions comparable to those of current turbofan-powered aircraft. The Advanced Turboprop Program will be implemented in three phases. This RTOP covers phase 1 of the program. In phase 1, wind tunnel tests will be performed to determine the aerodynamic and acoustic performance of two-foot-diameter models. The sound pressure level of advanced two-foot-diameter propeller models will be determined in flight tests or in wind tunnel tests at Mach 0.8. Propeller noise prediction programs will be developed to include thin swept propeller blades experiencing airflow greater than Mach 1.0. Propeller blade materials and structural concepts will be screened for feasibility and aeroelastic behavior. Preliminary designs for advanced large-scale propeller blades will be evaluated. Through analysis and wind tunnel model tests, the interactions of the propeller, nacelle, and wing will be evaluated. Propeller noise attenuation will be investigated by conducting fuselage wall acoustic attenuation studies, by performing model tests, and by investigating the feasibility of scaling fuselage acoustics. Design concepts for advanced gearboxes and pitch change mechanisms will be evaluated. Existing gas turbine shaft engines and cores will be screened for use as a propeller drive for phases 2 and 3.

W80-70177 **535-03-13**
Langley Research Center, Hampton, Va.
ADVANCED TURBOPROP - INTERIOR NOISE
D. G. Stephens 804-827-3561

The objective of this program is to demonstrate technology readiness in the area of acoustics and noise reduction for advanced turboprop aircraft development. Configurations of interest are aircraft-powered by highly loaded, multibladed turboprops for efficient, high-speed operation. Program emphasis will be on propeller noise and fuselage attenuation technology. The approach consists of the development of improved analytical and experimental methods for predicting propfan noise both in the near field and the far field and for predicting the transmission of noise through the cabin sidewall. These prediction methods will be developed and validated by means of model tests during the enabling technology phase of the program. The improved prediction methods will then be used to guide the design of low-weight, high-attenuation sidewalls for passenger acceptance and the design of propfans for acceptable fuselage as well as community noise exposure. The sidewall and propeller configurations resulting from acoustic considerations will be demonstrated by large-scale testing in the advanced component technology phase of the program.

W80-70178 **535-03-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED TURBOPROP - FLIGHT RESEARCH
R. S. Baron 805-258-3311

The objective is to develop and demonstrate by flight research the technology for advanced turboprop propulsion systems having high propulsion efficiences at cruise speeds and altitudes up to Mach 0.8 and 35,000 feet. This technology could provide fuel savings of 20% to 25% relative to current high-bypass turbofan engines while meeting reliability requirements and environment noise constriants. A two-foot diameter scale model of an advanced high tip speed propeller will be installed on a subsonic aircraft capable of flying Mach .8 at 30,000 feet altitude. Microphones will be placed on wing and fuselage and acoustic flight research will be performed to obtain near field noise data. A feasibility study by one or more aircraft manufacturers will be performed to investigate the various approaches to evaluate advanced full-scale turboprop engines either as a tested engine or as a replacement of existing aircraft engines. The lead technical engineer is Frank Olinger.

W80-70179 **535-04-12**
Lewis Research Center, Cleveland, Ohio.
ENGINE COMPONENT IMPROVEMENT PROGRAM
Joseph A. Ziemianski 216-433-6751

The objectives of the engine component improvement program are to: (1) develop components with improved performance that will reduce fuel consumption of current engines and be ready for introduction into new production (and where applicable the retrofit of these engines in the 1979-1982 time period), and (2) provide additional technology that can be used to minimize the performance degradation of current and future engines. The program is divided into two parts: performance improvement and engine diagnostics. The performance improvement part is aimed at developing fuel saving components for new production of the JT8D, JT9D and CF6 engines and for upgrading existing JT8D, JT9D, and CF6 engines. The primary elements of this part of the program are feasibility analysis, component rig/model tests, and full-scale engine tests. Components being evaluated include seals, clearance controls, fan, compressors, and turbines. The engine diagnostic part of the program will consist of analysis and test of the JT9D and CF6 engines to identify and quantify the sources and causes of engine performance deterioration with time. This information will be used to improve current engines and aid in the design of future engines.

Space Research and Technology Base

W80-70180 **506-51-11**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL AND EXPERIMENTAL AEROTHERMODYNAMICS
J. G. Marvin 415-965-5390

The objective is to establish aerbthermodynamic technology and configuration design concepts to improve vehicle safety, reliability, versatility, and aerodynamic efficiency with maximum payload for earth-orbital missions and planetary exploration. Advanced computational methods and computer codes will be developed for predicting vehicle flow fields and performance. Turbulence models (used in these computer codes) will be developed from building block numerical and physical experiments. New instrumentation techniques will be developed for the measurement of turbulence quantities in 3-dimensional flow fields.

Entry Fluid Physics Research and Technology

W80-70181 **506-51-13**
Langley Research Center, Hampton, Va.
SPACECRAFT AEROTHERMODYNAMICS AND CONFIGURATION TECHNOLOGY
B. Z. Henry 804-827-3911

The objective of this study is to develop configuration design concepts and the associated aerothermodynamic technology data base which will allow the achievement of space transportation vehicles operational in the 1990's and beyond which offer significant improvement in operational efficiency, economy, and safety. The intent is to study, both analytically and experimentally, configuration concepts utilizing technologies advanced beyond the base being established by the space shuttle. Specific studies will be directed toward solution of the aerothermodynamic problems associated with these concepts in such areas as

aerodynamic performance, viscous interaction and real gas effects, vortex interactions, heat transfer, basic configuration shaping, and optimization. Computational flow-field methods will be developed with emphasis on realistic configurations, and techniques for integrated configuration design, analysis, and optimization will be developed and continuously improved. Feasibility studies of the use of the space shuttle orbiter to obtain fundamental aerothermodynamic data applicable to future vehicle design will be pursued. Various perfect gas and real gas facilities will be utilized in experimental investigations to provide design data over a broad range of parameters.

W80-70182 **506-51-21**
Ames Research Center, Moffett Field, Calif.
PLANETARY PROBE AEROTHERMODYNAMIC TECHNOLOGY
H. K. Larson 415-965-5369

This effort is directed at providing the aerothermodynamic technology base in high-speed aerothermodynamics required for the design, development and verification of probes entering planetary atmospheres and to provide computational and experimental support, in a timely manner, for the specific development of planned and approved missions, in accord with the following targets: (1) to provide a complete understanding and prediction of the shock-layer and ablation product radiative gasdynamics for planetary entry vehicles; (2) to provide coupled flow field ablation solutions for outer planet probes; and (3) to support the aerodynamic development of planetary probe configurations and to provide the flight mechanics data in support of atmospheric reconstruction experiments. The coupled nature of outer planet probe aerothermodynamics requires a highly integrated computational and experimental program. The theoretical and experimental efforts in the area of shock layer radiation must be coupled with similar efforts in ablation product radiation and absorption. These efforts in turn must be coupled with research associated with shock layer flow which is highly blown by ablation products. In addition, the flight mechanics of the probe, both static and dynamic, are significantly affected by the ablation mass loss and shape change. Finally, all these theoretical efforts and experimental validations must provide the required aerothermodynamic input to outer planet probe development.

W80-70183 **506-51-23**
Langley Research Center, Hampton, Va.
PLANETARY MISSION SUPPORT
J. J. Jones 804-827-3031

This work is to provide computational and experimental support for aerothermodynamic problems in the entry of probes into the atmospheres of the planets. Emphasis is not only direct support for approved missions, but development of the data base required for planning of future missions. Direct mission support in the current year will focus on the Galileo mission to Jupiter. Key elements of this work are flow-field computations for the forebody, wake flow computations, and experimental measurements of ablation layer species absorption. Atmospheric reconstruction experiments are supported through ground-based tests and analyses. For this work, the emphasis is the determination of aerodynamic coefficients. The work is conducted primarily as an in-house effort with only certain specialized elements procured through contracts or grants. Aerothermodynamic environment definition is accomplished though development of benchmark solutions, accompanied by engineering solutions which are more efficient for parametric studies. Shock tube experiments of absorption properties for ablation species provide inputs to the computer codes. Calculation results are used to analyze such effects as turbulence in the shear layer, shape change effects on radiant heating, base region heating, radio signal attenuation, thermodynamic nonequilibrium, and the aerodynamic coefficients needed for atmospheric reconstruction experiments. The scope of this RTOP is reduced this year in that trajectory reconstruction analysis work is transferred to the new 506-26-43 RTOP.

W80-70184 **506-51-31**
Ames Research Center, Moffett Field, Calif.
OEX FLIGHT DATA ANALYSIS
H. K. Larson 415-965-5369

This effort is directed to provide the gasdynamic and aerothermodynamic technology base that is required to analyze the aerothermodynamic data of flight origin from Shuttle, Shuttle launched entry research vehicles, or engineering experiments on NASA atmospheric entry missions to improve aerothermodynamic design techniques for new vehicles and to enhance the aerothermodynamic efficiency of the Shuttle. This will be accomplished by addressing the following targets: (1) to compare data from Infrared Imagery of Shuttle (IRIS) and Development Flight Instrumentation (DFI) with Shuttle design techniques and advanced flowfield computations; (2) analysis of data on catalytic wall effects to compare with computations of reacting flows, (3) analysis and correlation of title gap heating data, and (4) comparison of data from Shuttle Infrared Leeside Temperature Sensing (SILTS) with advanced leeside flowfield computations.

W80-70185 **506-51-33**
Langley Research Center, Hampton, Va.
AERODYNAMIC/AEROTHERMODYNAMIC FLIGHT DATA ANALYSIS
J. J. Jones 804-827-3031

The objectives of this work are to carry out analyses of aerodynamic and aerothermodynamic flight data and compare the results with pertinent ground test data; to assess the adequacy and accuracy of theory and the techniques used to extrapolate ground test data to flight conditions; to define areas where improved methods, facilities, or additional data are needed in order to make reliable predictions of flight aerothermodynamic properties; and to identify areas for significant improvements in future orbiter modifications. Maximum use will be made of both orbiter and planetary probe entry data. Shuttle orbiter data will be analyzed beginning with the first orbital flight, making use of such instrumentation data as are available on a given flight, such as DFI, TFI, ACIP, SUMS, SEADS, and SILTS. This work will determine a best estimate of the entry trajectory and then use the nontrajectory data to determine aerodynamic coefficients and aerodynamic heat-transfer rates. The planetary probe work will make use of Pioneer Venus data to determine the aerodynamic coefficients and the planet's atmospheric structure. Ground work will begin for similar studies of the Galileo mission to Jupiter. Future spacecraft entries will be examined to determine what new data can be obtained to improve flight performance prediction techniques.

Chemical Propulsion Research and Technology

W80-70186 **506-52-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED CHEMICAL PROPULSION TECHNOLOGY
John W. Gregory 216-433-6849

The program being conducted has three major parts: (1) general advance research and technology; (2) low thrust chemical propulsion systems technology; and (3) advanced reusable space engine technology. The objectives of the general advanced R&T program are to provide improved understanding of basic chemical and physical processes in advanced chemical propulsion and technology improvements in performance, cooling, and reusability of liquid rocket components and subsystems. The low thrust chemical propulsion system technology program is a new focused technology program initiated in FY-79 having the objective of generating technology for propulsion systems for orbit raising of large, acceleration limited payloads. In this program parametric studies, vehicle interaction studies, low gravity fluid acquisition system studies, and component characterization activities have been started and will continue into FY-80. New work will be initiated in FY-80 on thrust chamber materials and cooling methods and propulsion system preliminary design studies to identify viable low thrust options and critical technologies

therefore and to select promising candidate systems(s) for further evaluation. In the advanced reusable space engine area the only remaining technology programs are in the turbomachinery area. This activity on the main fuel and oxidizer turbopumps, long life LH2 pump bearings, and boost pump drive will be completed by 1981.

W80-70187 **506-52-17**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED MANNED VEHICLE ON-BOARD PROPULSION TECHNOLOGY
R. W. Polifka 713-483-5495

The objective of this effort is to identify viable propulsion system designs and propellant alternatives which could replace N2O4/MMH in a second generation shuttle auxiliary propulsion system or similar advanced spacecraft propulsion systems and to establish the technology base necessary to allow for future systems development. Phase out of N2O4/MMH may become necessary due to handling hazards, high propellant cost and high corrosivity of these propellants. The LOX/hydrocarbon propellant family provides the most attractive alternative. LOX/hydrocarbon type propellants will be characterized and system design and trade studies conducted. Propellent and design selections will be made and critical component technology and technology issues will be identified. Component technology will be developed and carried forward into assembly level test evaluation.

W80-70188 **506-52-19**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED REUSABLE MAIN ENGINE TECHNOLOGY
Robert J. Richmond 205-453-3634

Activities are described which explore oxygen/hydrocarbon and oxygen/hydrogen systems required for advanced high pressure engines for future booster vehicles and for advanced main propulsion engines for future orbit-to-orbit vehicles. Single-fuel, dual-fuel, and dual fuel-dual throat engine concepts will be examined. The activities described include engine power cycle synthesis, parametric data generation, component performance prediction and evaluation, injector/combustor design and fabrication, combustor and turbine cooling investigation, turbomachinery dynamics analysis, evaluation of bearing and seal life extension techniques, dual-flow pumps, dual-fluid turbines, engine system control component design criteria, extendible nozzle surveys, sensing techniques investigation, and cryogenic propellant space storage and utilization assessments. These efforts include data screening, analyses, design, computer modeling, hardware fabrication, data evaluation and test.

W80-70189 **506-52-25**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LONG LIFE ADVANCED PROPULSION SYSTEMS FOR PLANETARY SPACECRAFT
P. I. Moynihan 213-354-3814

The objective is to create technology that will provide future planetary spacecraft with improved propulsion systems performance, lifetime, and other special characteristics. Four tasks are included in this RTOP. The first task will provide the safety background, evaluate new technology for safety-critical support items, and coordinate safety activity between the Shuttle Safety Office and the advanced liquid propulsion systems currently planned for future planetary missions. The work will complement the space storable system effort under RTOP 542-02-15, as well as other tasks in the RTOP. The second task will provide the research and technology base for a bipropellant pump-fed spacecraft propulsion system needed to replace the more massive, less efficient pressure-fed systems required for the high energy planetary missions planned for the mid-to-late 1980's and beyond. The study will concentrate on the integration problems of a turbopump/engine combination using presently available engines. The research will utilize a breadboard system to demonstrate the feasibility and performance of a spacecraft-type pump-fed propulsion system. Following the demonstration of an earth-storable system, work will be extended to space storable propellants. The third task will assess the storage lifetime of squibs by modern physiochemical means and identify design improvements. The fourth task will prepare and evaluate new higher-performance, solid propellant formulations based on standard hydrocarbon prepolymers and on dianhydride chain-extended and cross-linked binders. It will also demonstrate a solid propellant motor which will satisfy the high temperature requirements (such as heat-sterilization) of future planetary missions. A motor containing an 84% solids propellant and a stress-relieving insulation system will be heat-cycled and test-fired.

W80-70190 **506-52-33**
Langley Research Center, Hampton, Va.
ANALYSIS OF ENVIRONMENTAL IMPACT OF LAUNCH VEHICLE EFFLUENTS
C. J. Jachimowski 804-827-2065

The objective of this research is to develop a basic understanding of the chemistry of exhaust clouds from solid rocket vehicles, such as space shuttle, including the interactions of the exhaust clouds with ambient air; sunlight, natural clouds, and precipitation. The initial composition of the rocket exhaust at the solid rocket motor exit plane is only a starting point in determining the ultimate chemical and physical distribution of these products in the atmosphere and on the ground. The chemical composition of the exhaust cloud changes continually, rapidly at first as a result of high-temperature afterburning reactions, and then more slowly as a result of both photochemical and thermal gas and condensed-phase reactions, adsorption, turbulent and molecular diffusion, droplet nucleation condensation growth and evaporation, impaction collection, sedimentation, and various other interactive microphysical processes. Thus, a complete chemical characterization of the resulting cloud as a function of vehicle and propellant, probable atmospheric conditions, and time is needed to properly assess the environmental impact of the exhaust products with respect to (1) the deposition of acidic and/or oxidizing rain, and (2) the presence and deposition of highly toxic substances. This research is part of the technology base required by NASA to develop and substantiate the environmental impact statements for future NASA rocket launches.

W80-70191 **506-52-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY PROPULSION RESEARCH AND ADVANCED CONCEPTS
P. I. Moynihan 213-354-3814

The overall objective is to explore, create, and provide the new class of essential propulsion system technology which will be required to meet the demanding needs of the more ambitious NASA missions pending by the end of the century. Research will be conducted on selected analytical and experimental approaches which will contribute to the enabling technology for future high energy, long duration, and exploratory missions throughout the solar system. The specific tasks are (1) propellant production from planetary atmospheres: a study of advanced concepts of in situ propellant production to enable planetary exploration which either would not be possible or would be extremely difficult because of excessively high mission energy requirements, such as sample return missions; (2) advanced solid propulsion systems technology; the research and evaluation of high performance solid propulsion systems with respect to combustion instability and efficiency, mechanical properties, environmental stability, safety margins, spacecraft contamination, reliability, and thermal protection; and (3) liquid propulsion research and technology: the creation of improved methods for obtaining the greater performance and reliability required of spacecraft liquid propulsion systems, the evaluation of long term compatibility of propellants with conventional spacecraft materials, and the generation of a nozzle plume impingement and contamination effects mathematical model.

W80-70192 **506-52-39**
Marshall Space Flight Center, Huntsville, Ala.
PLUME CHARACTERIZATION AND LASER-HEATED PROPULSION
R. J. Richmond 205-453-3634

The effort is described which is directed at developing a chapter dealing with vehicle base flow and base heating for the JANNAF Plume Technology Handbook, developing a low altitude rocket plume flow field prediction computer program, and providing

a technology base for laser-heated propulsion. Existing computer programs and experimental data dealing with all areas of plume technology are being reviewed and documented in a JANNAF Plume Technology Handbook. The present year's effort is directed at preparing the chapter on vehicle base flow and base heating. A streamlined, low altitude rocket plume flow field computer program, or set of programs, will be developed by combining the best features of the existing programs into one new program. Laser radiation absorption experiments using pure hydrogen, seeded hydrogen and other propellant gases will be conducted. Experimental results will be compared with analytical predictions and a generalized thruster design model developed. Parametric analyses of thrusters using various propellants will be conducted. The more promising configurations will be selected for further analyses, and finally one configuration will be selected for fabrication and test.

Materials and Structures Research and Technology

W80-70193 **506-53-11**
Ames Research Center, Moffett Field, Calif.
SURFACE PHYSICS AND COMPUTATIONAL CHEMISTRY
E. E. Whiting 415-965-5690

The objective is to use experimental and theoretical techniques to develop a detailed understanding of the mechanisms which control important properties of matter and how they are modified by a wide range of environments. This understanding is leading to the development of new materials and processes needed by the agency for its technological advances. Properties of metallic interfaces are being determined by probing their structure at the atomic level. Knowledge of surface/environment interactions is being improved by studying gaseous surface reactions and how they relate to microscopic materials properties. Work has started on feasibility studies for mapping hydrogen concentrations on metal surfaces. The atomistic structure and properties of epitaxially adsorbed layers of metallic and semiconducting materials on well defined substrates is being investigated. Chemisorption, properties of catalytic particles, hydrogen-induced crack growth, and photo-enhanced chemistry are being studied theoretically. The key step in this work is the calculation of wavefunctions for molecules or atomic clusters which represent tiny bits of material. Properties of materials are obtained by extrapolating the results for the atomic clusters. Great emphasis is placed on continually extending the quality and scope of the wavefunction calculations because of their key importance in determining the properties of matter reliably. These efforts include improved precision, development of approximate methods applicable to larger systems and optimization of these computer codes for use on the evolving super computer.

W80-70194 **506-53-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FUNDAMENTALS OF MECHANICAL BEHAVIOR OF COMPOSITES MATRICES
J. Moacanin 213-354-3178

The long term objective of this work seeks to develop a more fundamental understanding at the molecular level of various synthetic plastic systems used in current and potential space and primary airframe structures. Applications for this research are aimed at the evaluation of long term performance of advanced composites as well as of the adhesively bonded interfaces, and will support advanced space power and transportation systems and large space structures. Of substantial interest in this respect are the composite matrix materials and their chemical components. From more detailed correlations of molecular properties with observed mechanical properties and failure mechanisms of composite materials, strategies will be developed for seeking molecular structures and composite systems which would exhibit higher performance, longer life and lower cost. Although the reinforcing fiber controls strength, it is the matrix that plays a dominant role in the control of fatigue life because failure occurs either in the matrix or at the matrix-fiber interface. Research in FY-80 will focus on developing a first-cut molecular parameter description of physical aging as manifested by volume and enthalpy relaxations. This is a necessary link between underlying molecular mechanisms and macroscopic material response. The approach includes determination of the time-temperature dependence of engineering properties (e.g., Poisson's ratio and creep) as function of chemical composition, morphology, process history, and physical and environmental aging. Fundamental aspects of chemical degradation processes will be investigated using electron spin resonance (e.s.r.) spectroscopy and related techniques to identify and characterize transient species induced by thermomechanical stresses.

W80-70195 **506-53-22**
Lewis Research Center, Cleveland, Ohio.
ADVANCED MATERIALS MANUFACTURING AND LUBRICATION PROCESSES
R. A. Signorelli 216-433-6606

The objectives of this program are to characterize the suitablity of present materials, identify improved materials and manufacturing processes, develop improved heat pipes, and better understand the friction, wear and adhesion behavior of materials for advanced space systems, such as propulsion, power generation and communication systems. Materials and manufacturing studies are aimed primarily at improving the specific modulus and strength properties of boron aluminum composites and lowering their fabrication costs; improving alumina/aluminum composites for structural applications; and evaluating space environment effects on mechanical properties of superalloys. Heat pipe studies emphasize greater efficiency, durability and economy through improved materials, working fluids, designs and processing methods. Lubrication studies include the effects of various environments on friction, wear and adhesion of non metallic, metallic, and ceramic systems; the chemistry and morphology of solid and liquid lubricants; the surface fatigue properties of candidate bearing and gear materials; and the development of cryogenic turbopump seals. Battery materials research includes studies of morphology of the alkaline zinc electrode and development and investigation of polymers for separator applications.

W80-70196 **506-53-23**
Langley Research Center, Hampton, Va.
MATERIALS FOR ADVANCED SPACE STRUCTURES
R. T. Swann 804-827-2969

The objectives of this research are to determine the durability of resin matrix composites in the space environment, and to develop advanced materials such as metal-matrix composites for future transportation systems and space structures. To assess the space durability of composites, detailed effects on materials of various types and levels of radiation will be determined and suitable methods for simulating the space environmental exposure on structural composites will be developed and verified by comparison with experimental data. Materials which have good long-term resistance to the space environment will be identified. For higher temperature applications, metal matrix composites, such as silicon-carbide/Ti, B/Al, silicon-carbide/aluminum, and other advanced structural materials will be developed and subjected to thermal, environmental and mechanical cycles. Residual mechanical properties will be evaluated, and degradation of these properties will be correlated with microstructural and physical changes. Analyses of diffusion, phase change, and chemical reactions will be developed, and these analyses will be applied to predict microstructural changes. Atomic models will be developed of point and extended defects and their interactions. Basic studies of molecular properties of matter will also be undertaken.

W80-70197 **506-53-25**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EFFECT OF SPACE ENVIRONMENT ON COMPOSITES
J. Moacanin 213-354-3178

The long range objective is to develop ultrafast pulse radiolysis as a tool for the determination of primary degradation processes caused by charged particles and to ultimately use this information along with conventional high energy exposure materials test data

to develop a reliable methodology for estimation of the long term effects of the space environment on polymers and composites. The objective in FY-80 is to generate rate effects data for candidate materials in order to assist the design of accelerated tests and facilities for NASA. Pulse radiolysis transient measurements will be used to determine rates of fast processes such as dissociation of a molecular ion, generation of an excited state from ion recombination or homolysis of an excited state generating a radical pair. Pulse radiolysis utilizing a pulsed electron beam and fast optical and esr detection assemblies can monitor these types of fast processes and measure their rates. These data, along with steady-state data, will be used to develop analytical models of degradation and a reliable prediction technology for 20-year lifetime applications.

W80-70198 **506-53-27**
Lyndon B. Johnson Space Center, Houston, Tex.
REFINING OF NONTERRESTRIAL MATERIALS FOR OXYGEN
R. J. Williams 713-483-2781

The primary objective is to study and quantify processes by which metals, oxygen, and other useful products might be obtained from nonterrestrial oxides and silicates, by studying theoretically and experimentally the physical chemistry of such processes. The work will use theoretical experimental techniques to obtain details and to quantify refining processes. The emphasis will be on processes using electrical, thermal or physical means for refining rather than chemical techniques. The work will involve in-house research studies emphasizing the electrolysis of refining gases using solid ceramic electrolytes and contracted research and study on electrical, thermal, or physical refining techniques.

W80-70199 **506-53-29**
Marshall Space Flight Center, Huntsville, Ala.
LONG TERM SPACE ENVIRONMENTAL EFFECTS ON MATERIALS
R. L. Gause 205-453-1500

The objective is to evaluate the long-term effects of the space environment on candidate materials for future long-duration space programs. The approach will be to assess future long-term programs to define potential materials requirements from design definition and mission environment profiles. Candidate materials will be selected for evaluation. An environmental test matrix will be developed for these candidate materials from the materials requirements. An appropriate test program will be performed to acquire the required data. A Space Materials Design Guide will be developed.

W80-70200 **506-53-31**
Ames Research Center, Moffett Field, Calif.
THERMAL PROTECTION SYSTEMS MATERIALS & SYSTEMS EVALUATION
H. K. Larson 415-965-5369

The objective is to provide thermal protection systems concepts and materials for heat shields to protect earth and planetary entry vehicles and planetary probes during atmospheric entry. The specific objectives are to: (1) develop improved fiber materials and minimum weight TPS to enhance the Space Shuttle and enable fully reusable advanced space transportation systems development; (2) develop planetary probe heat shield materials and determine methods to minimize heat shield weights; (3) develop concepts and heat shield materials for safe earth entry of radioactive power sources and to support DoD requirements. The system requirements for each end use are defined. Thermal protection materials parameters are determined that meet these requirements. Materials are either selected from the extensive technology in existence or new materials with optimized properties are developed. Candidate thermal protection concepts and materials are subjected to systematic analysis and testing to qualify them for the defined end use. Extensive unique Ames arc plasma test facilities developed for Space Shuttle and planetary entry probes are used in the experimental evaluations. Analytical studies are performed utilizing unique environmental computer codes developed by ARC that include detailed models of both the aerothermal environment and material response to obtain in-depth understanding of the material characteristics. Detailed temperature dependent radiation properties are computed for gaseous species required for thermal response analysis. Materials are often developed as a result of these studies to meet the ever more stringent requirements for atmospheric entry thermal protection.

W80-70201 **506-53-33**
Langley Research Center, Hampton, Va.
TPS MATERIALS FOR SPACE TRANSPORTATION SYSTEMS
R. T. Swann 804-872-2969

The objectives of this research are to provide heat shield testing to support the space shuttle program, and to develop improved thermal protection materials and systems for advanced space transportation systems. Available arc-tunnel and other facilities will be used as required to validate the space shuttle TPS. If problems are discovered in the course of this testing, inhouse programs will be undertaken to find solutions. Environmental exposure testing of RSI will continue. For advanced vehicles, new materials and materials configurations will be developed with emphasis on metallic materials. Emittance of high temperature alloys after exposure to flowing air will be determined. The possibility of increasing this emittance will be explored. High temperature creep will be studied; data will be generated on various alloys and a design methodology will be developed based on statistical analysis of the data. A model for cyclic creep will be developed. Thermomechanical processing techniques which improve creep resistance and other properties of materials will be evaluated. The possibility of developing a high performance carbon-carbon heat shield material will be explored.

W80-70202 **506-53-43**
Langley Research Center, Hampton, Va.
ADVANCED SPACE STRUCTURES
M. F. Card 804-827-3054

Research will be conducted on advanced structures and closely related technology areas that have been identified as key technology drivers in the design and development of future large space systems. The activities are intended to provide a technology base for both near and far term missions. The approach is to develop generic concepts and basic theoretical and experimental information in the structures, controls, materials and manufacturing areas. In the structures area, generic concepts for lightweight elements, deployable trusses and surfaces will be investigated. Analysis methods will be developed to size antennas and platforms and to estimate mass and cost. Methods of introducing damping by active or passive means will be investigated. Controls studies will focus on evaluation of new theoretical methods using distributed actuators and sensors. Electrostatic surface control concepts will be studied both theoretically and experimentally. Materials and manufacturing research will investigate effects of radiation exposure on composite materials and coatings and develop joining techniques for thermoplastic materials. Work will be coordinated with user requirements and more focused research being developed under the Space Structures Systems Technology Program.

W80-70203 **506-53-53**
Langley Research Center, Hampton, Va.
SPACE STRUCTURAL DESIGN METHODS
J. R. Davidson 804-827-3012

Advanced structural analyses and design methods will be provided to predict accurately and economically the performance, durability, and damage tolerance of future space structures and materials. Theoretical analyses and design efforts include research on new equations to represent structural behavior, the development of algorithms to improve the efficiency of computational methods, and the evaluation of minicomputers and microprocessors as computational tools to make complex analyses and design calculations feasible. Analyses will be developed to reflect and predict the failure modes observed in tests of damage tolerant composite structures. Emphasis will be on developing analyses to predict quantitatively the behavior of structures subjected to high static loads, repeated fatigue loads, thermally-induced stresses, and impact damage. Selected materials and structures will be tested to evaluate the accuracy of the advanced analyses.

W80-70204 **506-53-55**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
OPTIMIZATION OF STRUCTURAL SYSTEMS
J. A. Garba 213-354-2085

The principal objective of this research effort is to develop optimization methods and analytical tools for the efficient design of structural systems. The long range objectives are to develop optimization techniques considering interdisciplinary interactions in structural synthesis and to advance the state-of-the-art of optimization. The initial efforts will be centered around an existing state-of-the-art structural synthesis program, ACCESS-3. The computer program will be expanded to include capabilities which are essential to the efficient analysis and synthesis of aerospace structural systems.

W80-70205 **506-53-57**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED FATIGUE INVESTIGATIONS
R. G. Forman 713-483-4564

This RTOP is divided into the following three tasks in the order of priority for funding: (1) Stress-intensity factors for cracks from holes which includes the objective to derive accurate stress-intensity factor solutions for numerous practical crack from hole problems that occur in crack growth. As in the previous work at JSC a Green's function method will be used to solve the many two-dimensional type crack problems, and a finite element method will be used to solve the more complicated three-dimensional problems. (2) Low cycle fatigue characteristics of 6Al-4V titanium in a bi-axial stress field which is a task to improve the fatigue analysis of metal liners in composite overwrapped pressure vessels. (3) Procedures for selecting most critical flaw locations which is a task to be conducted by prominant fatigue analysts of aerospace structures to derive recommended procedures for selecting the critical locations for analysis of flow growth in fatigue loaded structures.

W80-70206 **506-53-63**
Langley Research Center, Hampton, Va.
SPACE VEHICLE DYNAMICS RESEARCH
M. F. Card 804-827-3054

The objective of this effort is to develop and validate advanced analysis and test methods for the prediction of dynamic and acoustic response of space transportation systems and payloads. A major part of the effort is to establish new analysis and test techniques for dynamic response which will permit rapid accurate prediction of the dynamics of new candidate payloads from knowledge obtained on early launch vehicle flights. In current studies, methods of using time-domain methods to assist in flight or ground test techniques will be investigated. Impedance procedures will be evaluated to improve load prediction techniques for payload launch vehicles. A method for correcting finite element models with vibration test data will be investigated. Development of rapid, accurate modal test methods will continue and include studies of the thermal acoustic response of launch vehicle thermal protection systems. The effort also includes basic work on tailoring the response of structures to dynamic inputs.

W80-70207 **506-53-65**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE VEHICLE DYNAMICS METHODOLOGY
J. A. Garba 213-354-2085

The principal objective of this five-year effort is to perform research and advanced development in dynamics criteria, design, analysis, and testing to develop and update analysis and test methods. Basic research will be performed in structural dynamics related to future problems such as large complex nonlinear space structures. These methods will be used for the prediction and verification of structural response and stability in support of advanced design, optimization and qualification of space transportation systems and payloads. The task will utilize existing data from flight programs (Viking, Voyager, and others) until the shuttle orbiter bay flight data are available.

W80-70208 **506-53-66**
Goddard Space Flight Center, Greenbelt, Md.
PAYLOAD ENVIRONMENTS AND DYNAMICS
J. P. Young 301-344-8284

The overall objectives are to produce improved means for generating vibroacoustic environmental design and test specifications for STS payload components and to develop schemes for protecting sensitive portions of payloads from intense vibroacoustic levels. Specific objectives are to develop and validate a rapid but accurate technique for predicting the random vibration environment of STS payload components, to validate and, if necessary, modify the PACES computer program designed to predict the orbiter payload bay acoustic environment, and to obtain orbiter payload bay flight data that is specifically suited for providing verification of payload design loads and environment prediction methods. The approach is to demonstrate the use of a computerized empirical data bank based vibroacoustic payload environment prediction system program (VAPEPS), to serve as the principal investigator for the LDEF/SBEM acoustic environment measurement experiment, to correlate measured flight acoustic data with math model predictions, via the DATE working group activity, plan and manage the acquisition, processing and utilization of shuttle payload flight environment data, and conduct in-house research on schemes for protecting sensitive portions of payloads from intense vibroacoustic environments.

W80-70209 **506-53-69**
Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE DYNAMICS
R. S. Ryan 205-453-2481

The overall objective is to demonstrate the capability of SEA (statistical energy analysis) techniques for predicting vibratory response. Intermediate objectives will contribute to accomplishment of the overall objective. An SEA computer model will be developed and established. Dynamic-prediction-technique development will be continued. The best prediction schemes/approaches will be identified (for optimizing computer techniques), and a shortcut methodology for assessment of dynamic loads of payloads will be identified, developed, and validated. This effort will require formulation, validation, and establishment of prediction and coupling methods/procedures. Methods, procedures, codes/programs will have to be keyed to contemporary test/flight data, ineffective SEA elements will have to be identified and purged, and simulation-validated innovations will have to be integrated into the SEA matrix. The following major task areas are being undertaken to accomplish the objectives: (1) component design and test criteria (high frequency), (2) improved structural fluid dynamic analysis capability, (3) acoustic environment accuracy requirements for response determination, and (4) payload loads.

W80-70210 **506-53-73**
Langley Research Center, Hampton, Va.
HIGH TEMPERATURE SPACE STRUCTURES
S. C. Dixon 804-827-3423

The objectives are to: (1) develop structural and TPS concepts required for improved efficiency, life and life cycle cost of airframes for space transportation systems; (2) define the aerothermal loads and flow/structure interaction parameters required for design of such structure; (3) evaluate structural concepts via radiant heating and mechanical loading tests; and (4) define aerothermal loads and evaluate TPS concepts via test in the 8-Foot High Temperature Structures Tunnel and the Thermal Protection System Test Facility. Focus current effort on hot metallic structures and metallic TPS concepts for earth-to-orbit vehicles.

Electronics and Automation Research and Technology

W80-70211 **506-54-13**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ROBOTICS/MACHINE INTELLIGENCE: AUTOMATED SYSTEMS
Carl Ruoff 213-354-6101

This plan covers a robotics and machine intelligence applications program to meet NASA's needs. The objectives are to develop and flight qualify technology. Specific objectives are: automated vision and recognition systems; automated mission operations and onboard command generation; automated techniques for handling assembly and construction in space; and concepts and requirements for highly automated spacecraft/ground systems in the late 1980's. The objectives will be accomplished by: (1) developing scene analysis techniques for real time control, feature detection techniques for analysis of large NASA image files, and pipeline processors which implement the highly parallel algorithms used for scene analysis and feature detection; (2) modify and improve the automatic problem solving system and apply learning and error correction techniques to the man machine interface; (3) continue the development of an assembly coordinator which facilitates communication between subprocesses, specify and begin implementation of a multimode manipulator control subsystem, perform dynamic manipulator control with force and visual feedback, extend visual sensing work to automatic control of manipulation, and prepare for shuttle-like manipulator automation tests; and (4) complete system studies to define detailed technology requirements and implementation strategies for highly automated spacecraft/ground systems.

W80-70212 **506-54-23**
Langley Research Center, Hampton, Va.
ADVANCED SPACECRAFT POINTING AND CONTROL SYSTEMS
N. J. Groom 804-827-3917

The objective is to develop analysis tools, conceptual designs, and hardware to further the long-range spacecraft guidance and control, and information systems goals of 10 times greater accuracy in spacecraft pointing systems; the development of long life navigation, guidance, and control system concepts; and the development of larger space structures control and pointing technology. To achieve these goals, new devices, concepts, and analyses are being pursued. These include: (1) spacecraft attitude control momentum storage devices such as the magnetically suspended Annular Momentum Control Device; (2) inertial sensors for aerospace vehicles such as the multifunction magnetically suspended Rim Inertial Measuring System; (3) analytical studies of the stabilization and control of large space structures; and (4) analytical studies of optimal maneuvering of large space structures. Through these efforts, technology is being developed to permit the design and implementation of cost-effective spacecraft pointing and control systems. System and component requirements as well as conceptual designs are being defined through the use of analysis and simulation. Effective system configurations, low-cost system integration, multipurpose operation, and component standardization will be used to reduce system and component costs while achieving required performance. Development of control and sensor hardware will be undertaken and critical hardware elements will be carried through laboratory evaluation to establish feasibility.

W80-70213 **506-54-41**
Ames Research Center, Moffett Field, Calif.
PHOTOPHYSICS AND LASER DIAGNOSTICS
R. L. McKenzie 415-965-6158

The objective is to incorporate modern laser technology and photophysics in a program to develop photodiagnostic techniques for the characterization of gaseous media in a dynamic state. In most cases, the gas will be flowing and may also be dynamically unsteady and thermally or chemically out of equilibrium. In the near-term, primary emphasis continues to be placed on the measurement of turbulent fluctuations in the state variables of cold transonic and supersonic wind tunnel flows.

W80-70214 **506-54-42**
Lewis Research Center, Cleveland, Ohio.
COMPONENT TECHNOLOGY AND RELIABILITY OF MICROWAVE AMPLIFIERS
R. E. Alexovich 216-433-6689

The objective is to develop the technology, concepts and components for extending life time and reliability of microwave amplifiers that require large current densities. To achieve this objective, research and technology development programs will be undertaken on various components of microwave amplifiers such as high current density thermionic and field emission type cathodes and beam forming and confining devices, the two elements which, to a high degree, determine the life and reliability of electron beam amplifiers.

W80-70215 **506-54-45**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELECTROPHYSICS
Gary R. Russell 213-354-3547

The overall objective is to carry out the research which is necessary for the development of sensors and sensing techniques required for the NASA atmospheric remote sensing program. Emphasis is placed on the research and development of new and unique sensors, required for specific missions, which are not available commercially. The following tasks are in support of this objective: (1) obtain spectroscopic information and cross sections for electron-atom, molecule, and ion interactions pertinent to various laser and plasma devices; (2) study fundamental interactions of ions, electrons, metastables and photons with molecules, in support of the development of UV-visible lasers for active remote sensing applications; (3) develop stable, compact and efficient FIR lasers for heterodyne receivers and develop efficient coupling schemes for FIR radiation; (4) improve the spectral purity of our pulsed TEA CO2 laser and its detection system to permit range-resolved species measurements to be made in the earth's atmosphere; (5) develop new methods of applied mathematics for nonlinear systems, and apply these methods to current problems dominated by the occurrence of solitons and nonlinear/dispersive waves; (6) develop new types of metal vapor and photochemical lasers in support of laser remote sensing applications; (7) demonstrate lasing in a submillimeter wavelength FEL device; (8) develop lasers where the laser pumping is provided by the products of nuclear reactions; (9) obtain information concerning electric, magnetic interactions and molecular dynamics in solids in search of a nuclear Zeeman maser and possibly delta laser schemes; and (10) demonstrate long lived population inversions achieved by spin-alignment of excited helium molecules created by electron bombardment of liquid helium.

W80-70216 **506-54-55**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FIBER OPTICS FOR DATA TRANSMISSION
A. R. Johnston 213-354-4054

The goal of the proposed effort is to conduct investigations and evaluations on the technology of devices critical to fiber optics data transmission, and to apply these results in feasibility tests on new system application of importance to NASA. Development of fiber optic data transmission technology will support OAST goals both in terms of a great increase in mission capability and a decrease in mission costs. The principal benefits to be expected from the use of fiber optics are the EMI immunity of the transmission line, its small size and weight, wide bandwidth, and ultimately lower cost than copper equivalents. The following applications will focus this work: (1) a high capacity ground-based data distribution link; (2) a fiber optic precise time link and; (3) a spacecraft data bus. Technology limitations and needed component development consistent with a greater than 1 G bit/sec data rate will be reported. Experiments will be conducted on high rate modulation of semiconductor lasers, and picosecond pulse generation. A single mode integrated optic waveguide switch will be evaluated. An initial evaluation of the status of other waveguiding components will be made. Feasibility experiments related to design of a link for transmission of precise time or phase between tracking antenna sites will be conducted. New applications in data transmission and sensing will be identified.

W80-70217 **506-54-58**
Goddard Space Flight Center, Greenbelt, Md.
MULTISPECTRAL ULTRASENSITIVE DETECTORS
H. W. Price 301-344-7101

The objective is the development of high performance earth and astronomy radiation detectors which are capable of measuring extremely faint sources at wavelengths from the far and XUV regions to the extreme IR. To accomplish this, various materials will be investigated to assess their applicability for specific detectors, and components will be developed for application in certain portions of the electromagnetic spectrum. High performance sensors will be developed which will complement the advanced optical instruments and telescopes being developed for use with shuttle flights and with new missions dedicated to observation and astronomical studies from space as well as on the ground. The goal is being accomplished through the use of an intensified charge coupled device (CCD) imager as the basic detector in a photon counting imaging system. The Imaging system may be used over a wide spectral range, extending from soft X-rays through the ultraviolet and visible into the infrared.

W80-70218 **506-54-59**
Marshall Space Flight Center, Huntsville, Ala.
ELECTRO-OPTICS: SUPERCONDUCTING INSTRUMENTATION
P. N. Peters 205-453-5134

Existing facilities for thin film deposition, microfabrication, and cryogenic measurements are being utilized to investigate and develop sensors based on superconducting electronic properties. These devices will be compatible with flight experiments requiring cryogenically cooled surfaces. Single and arrayed Josephson junctions, coupling techniques, fundamental material properties, and sensor/radiation interaction mechanisms are being investigated.

W80-70219 **506-54-63**
Langley Research Center, Hampton, Va.
ADVANCED ELECTRONIC COMPONENTS
J. A. Hutchby 804-827-3418

The objective of this research is to develop and evaluate advanced electronic components from GaAs and related high-speed III-V ternary and quaternary semiconductors. The aim is to provide a new integrated circuits (IC) technology capable of data processing speeds 10-20 times that of current advanced silicon devices for applications such as real time synthetic radar image processing, high speed data processing and telemetry for earth resources. The main thrusts are: (1) to develop a new GaAs voltage comparator linear IC for an ultra-high-speed A/D converter (1 gigasample/sec, 8 bit word), and (2) to fabricate/evaluate new metal-semiconductor field-effect transistors (MESFET's) on advanced III-V semiconductors.

W80-70220 **506-54-65**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FUNDAMENTAL ELECTRONICS
J. Maserjian 213-354-3801

This program pursues investigations in areas of LSI and multispectral sensors. These technologies are key to NASA's goal of high information return at low cost, yet important problems and limitations remain. In the area of LSI, the primary problems relate to flight qualification of LSI parts and the difficulty in acquiring, in a cost-effective manner, advanced or custom LSI designs with reliability assurance. These problems are being addressed in this program by five tasks ranging from fundamental studies to the development of advanced techniques for NASA-wide application. The approach to LSI qualification builds from a base of understanding from investigation of failure mechanisms and the structure of the active oxide-silicon interface region. Advanced electrical and surface analytical techniques are developed to make these studies possible, and to provide computer-automated measurement procedures that can be applied to appropriate structures on test chips and wafers. These test chip/wafers are designed for specific LSI fabrication lines to accompany the standard LSI part fabrication. Test procedures are then performed on these test chip/wafers to provide the data base needed for reliability assurance that is not accessible from the LSI parts, and as a means of screening process runs before costly part packaging and testing. Custom LSI is being addressed by a task, working in collaboration with MSFC, to develop a standard computer-based design system that can readily be used by all NASA centers. In the area of multispectral sensors, three tasks in this program address some of the problems relating to specific NASA needs. One task undertakes a basic investigation of the active interface of compound semiconductors, which is critical problem limiting the development of advanced CCD-IR detector arrays and submillimeter detectors. Another task deals with requirements for IR spacetelescope systems and is specifically investigating improved semiconductor and superconductor devices that operate at 0.3 - 3 K. The third task pursues basic studies of improved pyroelectric broad-band IR detectors for long-term operation without cryogenic cooling.

Space Power and Electric Propulsion Research and Technology

W80-70221 **506-55-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED ENERGETICS
Sol Gorland 216-433-6897

The objectives of this effort are to assess advanced concepts for space energy generation, conversion, storage and distribution and to develop the key technologies required to determine their feasibility. Advanced energetics concepts will be identified by literature search and communication with leading researchers. The concepts will be assessed by and contracted study and analysis. Experiments will be conducted on key technologies to determine concept feasibility. Selection among competing concepts will be made; followed by recommendations for system testing.

W80-70222 **506-55-13**
Langley Research Center, Hampton, Va.
ADVANCED RADIANT ENERGY CONVERSION
F. Hohl 804-827-3781

The objective is to conduct basic research on advanced concepts for the generation, transmission, and conversion of energy in space. Research will be performed to characterize radiation induced plasmas leading to efficient highpower conversion of concentrated solar and nuclear energy directly into electromagnetic radiation, laser power, or work. The interaction of fission fragments with uranium hexafluoride and with other gases will be determined. Radiation induced plasma will be studied to determine possible population inversion, nonequilibrium emission, and ionization and excitation cross sections. The possibility of new lasers in the ultraviolet and visible region with greatly increased power output will be studied. Studies for the selection of the most promising lasing medium and transitions will be performed for direct solar and nuclear excitation. Acutal nuclear-pumped laser tests will be performed using the U.S. Army Pulse Radiation Facility at Aberdeen, Maryland, and other reactors. Intense broadband UV and visible photon sources available at LaRC will be used to investigate broadband pumped chemically reversible lasers and plasma heating. Efficient methods of converting broadband and monochromatic photon energy directly to electricity and storable hydrogen and oxygen by photochemical conversion will be developed. New concepts, such as double electrode cells and protection of corrodible electrodes by inactive films or by passive electrolytes, will be investigated. Various grants and contracts will be used to perform supporting research under this RTOP.

W80-70223 **506-55-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADVANCED ENERGY TECHNOLOGY EVALUATION
Wayne Phillips 213-354-4051

The objective of this effort is to identify, evaluate, and, if justified, recommend for separate OAST funding, innovative advanced concepts in the area of energy generation, conversion, transmission and collection, which show promise to enable or significantly enhance future space missions. New and existing

concepts actively solicited from industry, universities, government agencies and individuals, will be evaluated by a team of nationally recognized experts in the energy field headed by the RTOP responsible individual. This evaluation will address basic physics of the concept, problem areas, and potential value if developed, as well as the feasibility of development of the concept. The highest-ranking concepts will be subjected to a more detailed assessment, funded out of RTOP resources, which might include systems studies, analytical modeling and/or the test and evaluation of experimental hardware. The results of these detailed assessments will be evaluated by the team and concepts of outstanding or potential merit will be recommended for separate funding by OAST.

W80-70224 **506-55-22**
Lewis Research Center, Cleveland, Ohio.
ELECTRIC PROPULSION TECHNOLOGY DEVELOPMENT
R. C. Finke 216-433-6119

The overall program objective is to identify and develop the technology for future electric propulsion systems for application to planetary and earth orbital missions. Technology for auxiliary electric propulsion systems will be identified and developed for stationkeeping and attitude control of geosynchronous spacecraft and future large space systems. An extended performance program is directed toward improving the performance of the 30-cm mercury thruster system in order to enable new planetary mission capability. The advanced primary propulsion technology program will define and develop primary electric propulsion technology to enhance the performance and reduce the cost of earth orbital missions. Promising technology concepts will be defined by analyses, study, and by basic research activities. Focused technology activities will be performed in order to characterize the performance and interfaces of critical elements of electric thruster systems, such as thruster and power processors. Tests and analyses of the critical system elements will then be performed to assure element interface compatibility and evaluate their lifetime and performance. Work will be performed both by in-house and contracted efforts.

W80-70225 **506-55-32**
Lewis Research Center, Cleveland, Ohio.
ION THRUSTER RESEARCH AND ION BEAM APPLICATIONS
R. C. Finke 216-433-6119

The objectives are to: obtain the understanding of the basic physical processes of electric propulsion and develop models in order to establish design guidelines, understand controlling processes, define interface criteria, and investigate alternative electric propulsion concepts to predict performance, life, and interface criteria. Examples of systems in an early development stage requiring further investigation are the inert gas bombardment ion thruster system and the synchronous linear accelerator (mass driver). Other objectives are to identify and evaluate nonpropulsive applications of ion thruster technology as well as the development of new or improved materials, processes, and products for nonpropulsive applications that are enabled by ion thruster technology.

W80-70226 **506-55-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MPD THRUSTER SYSTEM TECHNOLOGY
E. V. Pawlik 213-354-3455

The objective is to pursue research into the controlling physical processes involved in electric propulsion, to evaluate advanced concepts such as the MPD accelerator, and to investigate the nonpropulsive applications of electric propulsion technology. Specifically, this effort will establish the fundamental viability of the magnetoplasmadynamic (MPD) thruster by demonstrating that the problems limiting performance and lifetime can be resolved. The MPD thruster offers promise as a simple, high efficiency, low cost thruster. It requires high power, and thus, is particularly suitable to the high power levels expected to be available in the shuttle era as large power modules are developed. The high thrust densities attainable with this thruster make it suitable for use in near-earth payload transportation or for the exploration of the outer planets. Virtually every aspect of the MPD thruster system requires study in order to evaluate the potential benefit of this system. The approach will be to: (1) evaluate the technology associated with operating quasi-steady state MPD thrusters with pulsed energy transfer systems, (2) define the potential performance, efficiency and lifetime of the MPD thruster, (3) conduct a preliminary conceptual study of how a MPD thruster might be incorporated into either a solar electric propulsion or a nuclear electric propulsion vehicle, and (4) provide basic understanding of the physical processes involved in electric thrusters and the application of this technology to plasma-dynamic lasers. A target for this effort is to complete the preliminary technology development and evaluation of the MPD accelerator by the end of FY-81. With successful demonstration of this technology, efforts can then proceed with thruster development.

W80-70227 **506-55-42**
Lewis Research Center, Cleveland, Ohio.
SOLAR CELL TECHNOLOGY
D. T. Bernatowicz 216-433-4000

The objective is to improve conversion efficiency, reduce mass, reduce cost, and increase operating life of solar cells and blankets. Research and Technology programs will be continued in the following areas: (1) Radiation damage mechanisms in silicon solar cells; (2) High efficiency silicon solar cells; (3) Very thin cells with coplanar back contacts; (4) 14% cells with wraparound contacts; (5) Solar cells fabricated with automatable; low cost processes; (6) Very thin covers, and modules; (7) Gallium arsenide solar cells; and (8) Concepts with the potential for 30% conversion.

W80-70228 **506-55-43**
Langley Research Center, Hampton, Va.
SOLAR CELL RESEARCH
E. J. Conway 804-827-3781

This basic research program is broadly oriented toward developing the technology to improve conversion efficiency, reduce mass, reduce cost, and increase the operating life of GaAlAs/GaAs solar cells. The R and D to achieve high efficiency (18 to 20% in space) GaAlAs solar cells with high temperature (200 - 300 C) operating capability, low weight and long life in a radiation environment is being performed for potential space applications, such as long duration solar electric propulsion, a space power station, or a Solar Polar Mission. Currently this program emphasizes the effects of proton and electron irradiation on cells and cell materials, optimization of the structure to maximize radiation stability, and annealing to heal radiation damage. An effort near completion aims toward characterization of these solar cells at temperatures from 25 C to 300 C. A new research emphasis involves thin crystal p-n junction cells for potential large space-power applications. Liquid and vapor phase epitaxial growth are employed to develop approved cells. In addition, the program generates new cell concepts and techniques through funding and encouragement of universities and industries. This program no longer includes research on computational chemistry or 3-5 semiconductor devices.

W80-70229 **506-55-45**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY SOLAR ARRAY RESEARCH & TECHNOLOGY
W. A. Hasbach 213-354-6132

The overall objectives are: to improve conversion efficiency, reduce mass, reduce cost, and increase the operating lifetime of solar cells and arrays. The following tasks are in support of the above objectives and targets of the FY80 PASO: (1) demonstrate flight readiness of the OAST 50 micrometers thin solar cells (4 sq cm) having efficiencies >13 percent, and production readiness/cost effectiveness of the 50 micrometers thin large area, (equal to greater than 25 sq cm) solar cells having efficiencies >12 percent; (2) develop a greater understanding of the parameters necessary to post radiation anneal solar cells, as well as test and evaluate advanced design cell types, including those developed for DOE, to obtain an improved understanding of cell performance in space; (3) develop for flight qualification testing, a high performance blanket technology employing OAST thin cells having a specific power greater than 240 W/kg, and demonstrate a cost effective approach for on panel annealing in

order to extend mission lifetime in geosynchronous orbit; (4) develop concentrator enhanced photovoltaic arrays for outbound and geosynchronous missions using ultra lightweight solar blankets; as a goal this technology should be capable of developing > or = 75 W/sq m at 5 AU (Jupiter), > or = 22 W/sq m at 10 AU (Saturn and provide higher specific power in earth orbital applications; and (5) develop a technology enabling the fabrication of GaAs solar cells with an efficiency of 15-17 percent capable of furnishing 400 W/kg blankets, and having less than 25 percent efficiency loss after 30 years equivalent of irradiation exposure in orbit.

W80-70230 **506-55-46**

Goddard Space Flight Center, Greenbelt, Md.

ATS-6 SOLAR CELL RADIATION DAMAGE EXPERIMENT AND A COMPILATION OF SOLAR ARRAY TESTING AND FLIGHT PERFORMANCE RESULTS

L. W. Slifer 301-344-8841

The objective is to extend the collection, analysis, and reporting of data from the ATS-6 Solar Cell Radiation Damage Experiment and to compile, correlate, and analyze results of the solar array testing and results of flight performance. The final product will be reports of the ATS-6 results plus a document in which information pertaining to GSFC in-house solar array design, components, materials, etc. and their environmental performance in test and in flight is consolidated.

W80-70231 **506-55-49**

Marshall Space Flight Center, Huntsville, Ala.

EARTH ORBITAL PHOTOVOLTAIC ENERGY CONVERSION

William L. Crabtree 205-453-2110

The objectives are to advance the state-of-the-art in multi-kW solar arrays for earth orbit and to augment SEP array technology. This is necessary for support of future NASA missions such as Space Construction Base and Public Service Platform Missions. The RTOP will consist of the following tasks: (1) Low cost multi-100 kW solar array concept and technology development: refine conceptual design and perform investigation of subsystem, component and materials technology status vs. application and identify specific deficiencies; perform materials, components and subsystem technology development. (2) Investigation of theoretical concepts for power generation - perform evaluation of thermovoltaics and spectrophotovoltaics by analytical and experimental means in order to assess their capability to provide low cost multi-100 kW power. (3) SEP solar array technology augmentation - augment SEP solar array technology to incorporate the thin-cell blanket and low cost solar cell.

W80-70232 **506-55-52**

Lewis Research Center, Cleveland, Ohio.

ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE

Stuart J. Fordyce 216-433-5160

The objective of this program is to attain long life, high energy density, high reliability, and lower cost of electrochemical energy storage and conversion devices. The emphasis is on alkaline secondary batteries, high density batteries, technology and designs for improving life and H2-O2 alkaline fuel cells to operate with long endurance and higher efficiency. During FY-80, a commercial supplier of the inorganic-organic alkaline battery separator will be achieved and development of the crosslinked polymeric separator initiated. A > 200 Whr/kg chalcogenide positive sodium negative cell will be optimized. New polymeric separator materials for high energy non aqueous lithium cells will be defined. Seventy-seven Whr/kg, 10 yr. synchronous orbit, 50 AH silver hydrogen cells will be validated and the technology transferred to users. The lightweight (55 Whr/kg) nickel cadmium program will be supported with all pre-prototype components under test in sealed cells and an optimum cell design for rapid deep discharge reconditioning defined. Multi-kilowatt hour storage technology will continue. The > 100 AH torridal nickel cadmium cell feasibility will be demonstrated and cell development begun, evaluation of alkaline electrolysis oxygen electrocatalyst endurance for 5000 hr. completed and single cell technology optimized for the alkaline fuel cell for 40,000 hr. life. A state-of-the-art assessment for fuel cell electrolyzer storage systems will be completed. A high power density single fuel cell will be optimized and endurance testing completed on a 30 cell lightweight alkaline stack built by Marshall Space Flight Center.

W80-70233 **506-55-55**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

ADVANCED NICKEL-CADMIUM AND LITHIUM BATTERIES

I. Stein 213-354-6048

The objective is to provide the technology base for future space battery power systems needed for use in near-earth space and in the exploration of the solar system. The specific objectives are to develop advanced nickel-cadmium and advanced orbiter and probe batteries with improved energy density, longer life, and extended operational capability. The effort involves two major tasks with the following objectives: (1) experimentally verify accelerated nickel-cadmium test methodology by the end of FY-80 and double the life and/or useable energy density of nickel-cadmium batteries by the end of FY-81; and (2) demonstrate a safe 300 W-hr/kg probe and lander primary lithium battery with storage life greater than 5 years by the end of FY-82, and establish feasibility of a safe secondary lithium battery with energy density of 220 W-hr/kg by the end of FY-82. The approach will be as follows: Increased life and energy density of the nickel-cadmium system will be achieved by developing and testing new technology components and integrating them into an optimized design and by developing better understanding of failure mechanisms and accelerated/predictive test methods. High energy density primary and secondary batteries will be achieved by development, test, and qualification of lithium batteries based on candidate couples such as Li-SOCl2, and Li-TiS2.

W80-70234 **506-55-57**

Lyndon B. Johnson Space Center, Houston, Tex.

ORBITAL ENERGY STORAGE AND POWER SYSTEMS

David Bell, III 713-525-6491

The objective of this research effort is to advance fuel cell and electrolysis cell technology to maturity and to demonstrate suitability to large orbital energy conversion and storage requirements for high power, long life systems. A data base will be developed using a hydrogen/oxygen 5 to 7 KW sized unit test. An engineering model will be fabricated and delivered for field demonstration. In addition, a hydrogen/halogen regenerative test unit will be developed and tested to generate a data base to assess its potential to meet the bulk energy storage needs of future NASA missions. A primary battery evaluation is proposed to quantify performance for very high rate demand needs for future NASA space systems.

W80-70235 **506-55-65**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

THERMAL-ELECTRIC AND THERMIONIC ENERGY CONVERSION TECHNOLOGY

J. F. Mondt 213-354-6847

The objective of the supporting technologies in this RTOP is to develop the thermal-to-electric conversion technology and demonstrate the feasibility for providing a power subsystem for the exploration of the solar system and its surroundings with emphasis on system reliability, payload delivery capability and integration with the launch vehicle. To meet the above objective the development efforts are divided into tasks: The first task (1) provides the design of the power subsystem which is compatible with the mission requirements; (2) delineates the critical technologies and alternatives which need to be demonstrated; and (3) demonstrates feasibility of the critical technologies in the area of heat source interface, heat pipes, high temperature insulator and heat rejection system. The second demonstrates the technology feasibility of thermionic conversion at the temperature (1600 to 1800 K), power density and efficiency required for the power subsystem as defined in the first task. Fabrication, test and evaluation of thermionic converters having a high efficiency configuration with improved electrode materials is used to develop and demonstrate technology readiness. Also this task develops and demonstrates thermoelectric materials technology at temperatures and efficiencies required for the power subsystem as defined in the first task. Fabrication, test

and evaluation of T/E materials is used to demonstrate technology readiness. The third task develops new thermoelectric materials to provide a reliable, high efficient and cost effective conversion system compatible with existing radioisotope heat sources. Analytical and experimental investigation of new materials with potentially high efficiencies will be conducted.

W80-70236 **506-55-72**
Lewis Research Center, Cleveland, Ohio.
POWER SYSTEM MANAGEMENT AND DISTRIBUTION
R. C. Finke 216-433-6119

The objective is to provide the technology base for multi-KW space power systems and subsystems, including solar photovoltaics, energy storage electrical components, circuit concepts, environmental interactions with space plasma, power processing, transmission and distribution needed for semi-permanent low earth and geosynchronous power-systems in the mid 1980's to mid 1990's. The proposed work will define and develop the technology necessary to both extend shuttle capabilities and establish central utility power capabilities essential to the habitation and development of near earth space. In-house and contractor studies will be conducted to determine performance requirements, identify system constraints, estimated cost, weight and size of potential space power systems, identify new technology needs, and determine benefit/cost ratio of proposed technology programs. Contractor/in-house analysis and experimentation will be used to define, develop and test components, circuit concepts, subsystems and systems. Investigations will be conducted to evaluate interactions between the space plasma environment and spacecraft surfaces at various voltages. Design guidelines for controlling these interactions will be issued. A strong activity will be maintained to coordinate with and support work at other NASA centers.

W80-70237 **506-55-75**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY POWER SYSTEMS R & T
A. O. Bridgeforth 213-354-5626

The overall objective is to provide the technology base necessary for the very high-performance power systems required for long-life untended operation in hostile environments. The objective of this first task is to develop the capability of a spacecraft power system to automatically perform monitoring, computational, command, and control functions without the need for ground intervention. Future planetary exploration missions will results in long round-trip signal time and large variations in power system operating parameters preventing the proper management of these power systems through conventional Earth-based monitoring and command functions. An existing spacecraft power system has been modified to incorporate selected APSM functions to demonstrate technology feasibility. A performance evaluation, and a solar array/battery APSM handbook will be prepared by the need of FY-80. Advanced development will be performed to evolve the APSM technology to the point of flight technqlogy readiness by the end of FY-83. This technology development will be guided by the particular requirements of future (FY-84 - FY-90) missions. The objective of this second task is to develop a lightweight power source capable of surviving the intense Mercury thermal environment. Various solar thermoelectric generators (STG) configurations will be evaluated and demonstrated in a 10-16 sun simulation to ascertain feasibility and technology readiness by the end of FY-82. The STG development represents an enabling technology for the Mercury orbiter and other near Sun missions.

W80-70238 **506-55-77**
Lyndon B. Johnson Space Center, Houston, Tex.
HIGH VOLTAGE PLASMA INTERACTIONS AND THERMAL MANAGEMENT FOR ON-ORBIT ENERGY SYSTEMS
J. E. McCoy 713-483-2956

The plasma interactions experiments objective is to provide a direct link between smaller scale experimental data, analytical models and space flight systems involving high voltage plasma interactions, by using a combined experimental and analytical study of the development of high voltage plasma sheaths surrounding 1-10 meter models. The program will: (1) allow verification and scaling of (power leakage) data obtained in smaller scale experiments, (2) develop computer models for use in design of high voltage space power systems for use in low orbit and (3) provide for preflight test and calibration of related flight test systems using the 20 meter dia. plasma lab facility at JSC.

W80-70239 **506-55-79**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-kW LOW-COST EARTH ORBITAL SYSTEMS
J. R. Graves 205-453-2514

The objectives are to provide the technology and capability within NASA to process, distribute, and control electrical power in multi-100 kW type systems and to reduce space energy costs through improved efficiency, life, reliability, and maintenance. This effort will consist of the following tasks: (1) establish component and subsystem requirements, sizes, voltages and sensitivities and rank critical technologies consistent with overall system development; (2) design and develop the necessary power processing/conditioning circuitry for high voltage, multi-kW power systems; (3) develop utility-type power management and control techniques for space power systems; and (4) construct a system breadboard for evaluation and demonstration of new technologies and power management and control techniques.

W80-70240 **506-55-82**
Lewis Research Center, Cleveland, Ohio.
ION THRUST SUBSYSTEM TECHNOLOGY FOR SOLAR ELECTRIC PROPULSION
R. R. Lovell 216-433-6685

The overall program objective is to develop electric propulsion thrust subsystem technology. The program is directed toward demonstrating the technology readiness of a baseline system by the end of 1980. Some test runout in FY-81 is expected. The baseline thrust subsystem is based upon a electron bombardment mercury ion thruster that is 30cm in diameter with a beam power of 2.2KW and specific impulse of 3000 seconds. The approach in the baseline program is to develop engineering model thrusters, to develop functional model power processors, and to integrate the resulting thrusters and power processors into a thrust subsystem module for test and evaluation. The program also includes endurance testing engineering model thrusters and performing test evaluation in the long term multiple (3) thruster mission profile life test using multiple thrusters and powers processors.

W80-70241 **506-55-82**
Lewis Research Center, Cleveland, Ohio.
PRIMARY ELECTRIC PROPULSION SYSTEMS
R. R. Lovell 216-433-6685
(506-22-62)

The overall program objective is to develop electric propulsion thrust subsystem technology. The program is directed toward demonstrating the technology readiness of a baseline system by the end of 1980. Some test runout in FY-81 is expected. The baseline thrust subsystem is based upon an electron bombardment mercury ion thruster that is 30 cm in diameter with a beam power of 2.2 KW and specific impulse of 3000 seconds. The approach in the baseline program is to develop engineering model thrusters, to develop functional model power processors, and to integrate the resulting thrusters and power processors into a thrust subsystem module for test and evaluation. The program also includes endurance testing engineering model thrusters and performing test evaluation in the long term multiple (3) thruster mission profile life test and in system interaction tests using multiple thrusters and power processors.

W80-70242 **506-55-85**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ION PROPULSION INTERACTIONS AND TECHNOLOGY QUALIFICATION
E. V. Pawlik 213-354-3455

The objectives are: (1) to understand and characterize the interactions between solar electric propulsion (SEP) spacecraft and operating ion propulsion thrusters; (2) to determine the constraints that these interactions might place on propulsion system and/or spacecraft designs; and (3) to demonstrate

solutions to interaction and interference problems through the testing of a thruster subsystem with typical elements of spacecraft subsystems. Potential problem areas such as EMI, and thruster plume effects will be emphasized. Two major task areas for FY-80 have been planned. These are an experimental effort to characterize thruster EMI levels, and an experimental effort to characterize the thruster plume. This work is directed toward completing a preliminary investigation of ion propulsion thruster interactions with planetary spacecraft by the end of FY-80. The test facilities at JPL and the bimod test setup at LeRC will be utilized in the conduct of these tests. Tests at LeRC will be conducted jointly, as described in RTOP 506-55-82, with management responsibility for these tests residing with JPL.

Multidisciplinary Research

W80-70243 **506-56-11**
Ames Research Center, Moffett Field, Calif.
FUND FOR INDEPENDENT RESEARCH (SPACE)
G. T. Chapman 415-965-5654

It is planned to support innovative and discretionary basic research in areas related to space. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space including the technical field of lasers, energetics, materials, applied mathematics, superconductivity, chemistry and physics. The OAST Research Council and the Ames Funds for Independent Research (FIR) Committee review unsolicited proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Council and FIR Committee to be worthy of support on a scientific or engineering basis are selected as candidates for funding.

W80-70244 **506-56-12**
Lewis Research Center, Cleveland, Ohio.
FUND FOR INDEPENDENT RESEARCH (SPACE)
W. E. Moeckel 216-433-4000

The objective is to support innovative and discretionary basic research in areas related to space. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space including the technical field of lasers, energetics, materials applied mathematics, superconductivity, chemistry, and physics. Members of the Lewis Research Advisory Board, at the request of the Chief Scientist, review unsolicited research proposals that have been judged to be worthy on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Board to be worthy of support on a scientific or engineering basis are selected as candidates for funding. These proposals are then prioritized by the Chief Scientist and funded to the extent permitted by available resources. The Chairman of the OAST Research Council is kept informed of funding plans to prevent duplication and to provide coordination. Progress and results are reported periodically by the Grant Monitor and submitted on the Chief Scientist for review and for distribution to OAST Research Council.

W80-70245 **506-56-13**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (SPACE)
W. D. Erickson 804-827-2471

The objective of this plan is to support basic research in universities in areas related to space through the funding of a limited number of unsolicited research proposals from various universities. University research proposals that have been judged to be well worth supporting on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs, are considered. University research proposals that have been evaluated and are not funded through any of the research programs are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be well worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be the more innovative and aimed at the longer term research of potential relevance to future NASA space programs.

W80-70246 **506-56-16**
Goddard Space Flight Center, Greenbelt, Md.
FUND FOR INDEPENDENT RESEARCH
T. Kostiuk 301-344-8431

The objective is to conduct basic research in the field of remote detection, spectroscopy and imaging in the middle infrared using infrared to visible upconversion techniques. The program pursues a basic investigation of new technology in fundamental science and engineering needed to satisfy NASA requirements in space; specificially the development of laser technology and laser systems applicable to highly sensitive infrared detection of atmospheric, astronomical and astrophysical sources. The approach is to theoretically optimize the design and performance characteristics of intra-cavity upconversion systems, construct such systems and experimentally verify theoretical predictions, investigate the physics involved, analyze and test the application of these systems to astrophysical observations.

Information Systems Research and Technology

W80-70247 **506-61-13**
Langley Research Center, Hampton, Va.
DATA SYSTEMS CONCEPTS: SOFTWARE SUPPORT SYSTEM TOOLS & TECHNOLOGY
E. C. Foudriat 804-827-2077

The objective is to define and develop support software tools and technology which will provide for the effective utilization of digital electronics in avionic and space flight systems. To be effective, it must involve the user (e.g., research, flight test engineer) in all stages of program development and checkout so he maintains visibility and continuity with his flight test objectives. It must also keep pace with the rapidly advancing and changing computer hardware developments. The approach is to develop flexible software language systems, validation, and test procedures whereby the particular hardware characteristics system can be made semi-transparent yet efficient to the user. These software techniques will be developed and tested by application to NASA flight test programs and will be available to NASA, other government agencies, universities, and industry.

W80-70248 **506-61-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADAPTIVE DATA HANDLING: DIGITAL DATA SYSTEM
D. D. Lord 213-354-4117

The digital data system task has been identified as an area of critical technology requiring development for the NASA end-to-end data systems (NEEDS) program. The digital data system provides the onboard command and data handling functions for both near-earth and deep space type spacecraft. The objective of this task is to develop a modular, distributed processor data system utilizing microprocessor and other LSI technologies to provide basic data system building block hardware/software elements. Systems architectures are designed such that the basic building block elements can be assembled as required to meet particular project capability and reliability requirements. The ability to increase capability and reliability in a modular fashion, along with the programmable nature of the system, results in an on-board data system with both multimission and real time adaptive capability. Specifically the RTOP will include: (1) selection of a standard 16-bit microprocessor; (2) selection of a standard intercommunication data bus system; (3) design, fabrication, test, and documentation of the breadboard implementation of an on-board distributed microprocessor data

system; (4) incorporation of the modular data transport system (MDTS) NEEDS Phase 2 requirements in the digital data system design; (5) design, fabrication, test, and documentation of an 8-bit microprocessor implemented remote terminal unit as a candidate for a NASA standard (Completed in FY-79); and (6) development of software programs and design aids to support hardware elements.

W80-70249 **506-61-16**
Goddard Space Flight Center, Greenbelt, Md.
DATA SYSTEM CONCEPTS: RESOURCE EFFECTIVE DATA SYSTEM (REDS) STUDY
R. D. Price 301-344-7377

The REDS study is one of the elements within the Office of Aeronautics and Space Technology NASA End-to-End Data System (NEEDS) Phase I Program. This research describes the REDS study effort. The objectives of this study are: (1) to determine and quantify the demands placed on the NEEDS; (2) to describe the NEEDS and quantify its performance and costs; and (3) to examine alternative future data system concepts for potential implementation in the end-to-end system and quantify their performance and cost. The broad technical approach is to perform a logical series of specific work tasks which include collecting data on current and future mission profiles, user requirements, and data system descriptions; developing a modeling, simulation, and analysis capability; and utilizing the collected data in the modeling and simulation system to test and evaluate new data system concepts. The final task will be to generate recommendations to management for implementation of technologically mature data systems and for initiation or continuation of new data systems technology development. The objectives will be considered to be successfully accomplished upon completion of this final task. This study supports the long range goal of the NEEDS program to identify, define, and demonstrate technology and techniques in a total end-to-end system concept which will provide orders-of-magnitude increases in useful information return from missions of the 1980's.

W80-70250 **506-61-23**
Langley Research Center, Hampton, Va.
ON-BOARD INFORMATION PROCESSING
Charles Husson 804-827-3535
(506-20-23)

The objective of this work is to investigate and develop new signal and data processing technologies to enhance the performance of operational and analytical spacecraft systems. The specific objective is to develop stand alone, lightweight, real time programmable processors for data manipulation and computational applications suitable for analysis of Landsat multispectral data. This work is to further investigate and develop new signal and data processing technologies for high speed, reliable and low cost information processing on board spacecraft. Current research efforts include the development and evaluation of a programmable CCD processor to perform classification of multispectral data. This processor will be delivered in this work period and demonstrated as a Landsat data classifier. New work includes the implementation of new mathematical transforms that convert from a cartesian frame to a polar coordinate system, linear predictor matrix operators and other higher ordered subsystem primitives usable in spacecraft information processing systems.

W80-70251 **506-61-26**
Goddard Space Flight Center, Greenbelt, Md.
ON-BOARD DATA PROCESSORS: PARALLEL PROCESSING TECHNOLOGY
David H. Schaefer 301-344-5184

The objective is to develop hardware and software especially suited for very high speed analysis of data. Such hardware and software is especially needed for rapid analysis of high rate digital image data as generated by Earth Observation and planetary spacecraft. The approach consists of carrying out the required technological development of hardware components in order to fabricate a Massively Parallel Computer suitable for sophisticated high speed on-board processing of large volumes of data. Compact, low power, very high speed computing systems will be available for use on-board spacecraft and other NASA vehicles as a result of this technology development. These systems will be especially useful for the processing of images.

W80-70252 **506-61-32**
Lewis Research Center, Cleveland, Ohio.
HIGH EFFICIENCY TECHNOLOGY FOR MICROWAVE AMPLIFIERS
R. E. Alexovich 216-433-6689

The objective is to provide, through research, design data and tests, the technology base for development of high efficiency, high power microwave amplifiers for space and airborne applications, capable of real-time handling of data in space and state-of-art jamming power in ECM systems. To achieve this objective research and technology development programs will be undertaken on several types of microwave amplifiers applicable to high efficiency requirements from 1 to 100 GHz. Specific techniques such as multistage depressed collectors and spent beam refocusing and development of methods for high efficiency performance in the linear, low distortion region will be pursued. Investigation of low loss, high efficiency circuits will be continued.

W80-70253 **506-61-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH SPEED DATA TRANSFER: X/S BAND COMPONENTS
J. F. Boreham 213-354-4107

The general objectives are to develop microwave subsystems and techniques which increase data transfer by a factor of 10 to 100, improve radio navigation accuracy by factors of 10 to 1000, improve carrier tracking stability by two orders of magnitude enabling gravity wave detection, improve communications component reliability by a factor of two, and reduce cost and weight of these components by at least one-third. The approach incorporates the following key items: (1) development of an X-band transponder including increased ranging channel bandwidth and stability, and compatibility with one-way differenced ranging navigation: (2) develop an 8/21/32 watt, X-band solid state power amplifier (XSSPA) with overall DC to RF efficiency approaching 30% as a replacement for expensive, unreliable TWTA; and (3) perform tradeoff studies to determine how best to achieve greater telecommunications performances needed for future mission and yet reduce spacecraft cost and weight. Early flight experiments will demonstrate two features of the X-band transponder. These include: a wideband one-way Delta VBLI ranging capability for the Galileo mission providing improved navigation accuracy at low declination angles; and in conjunction with OSTDS RTOP 310-20-64, an X-band uplink capability for ISPM enabling the search for gravity waves. The XSSPA will use a modular concept which will retain functional compatibility with the array feed power amplifier approach which was demonstrated in FY-78 and is necessary for the eventual development of Electronic Beam Steering.

W80-70254 **506-61-36**
Goddard Space Flight Center, Greenbelt, Md.
HIGH SPEED DATA TRANSFER, S/K-BAND COMPONENTS AND TECHNIQUES
Dominick E. Santarpia 301-344-6375

The objective is the advancement of Spacecraft Technology in Tracking, Data Generation and Data Transfer to satisfy the demanding communications requirements of future flight programs. The flight programs of the 1980's are characterized by high data rates (up to 600 Mb/s), simultaneous multi-link and reliable long life operation. The accommodation of such requirements shall be achieved through technological advances in Spacecraft RF/microwave techniques and components.

W80-70255 **506-61-39**
Marshall Space Flight Center, Huntsville, Ala.
HIGH SPEED DATA TRANSFER, S/K-BAND COMPONENTS AND TECHNIQUES
G. A. Bailey 205-453-1595

The long-range objective is to provide the technology and techniques necessary to construct a low-cost optical reader/recorder system capable of interfacing with an information

distribution system. The primary application of this effort is a laser-oriented system to utilize data from the Archival Mass Memory in the NASA End-to-End Data System (NEEDS) Program. The reader system must be able to utilize high density (10 to the 7th power/sq cm), high capacity (10 to the 10th power bits/unit record), fast (20 Mb/sec read) data and must be inexpensive enough to be afforded by most users of satellite-acquired, time-sensitive data. A feasibility breadboard system has been configured to demonstrate the retrieving, indexing, and registration of high-density data storage units. The fundamental technology required to implement the archival memory is available such that no technology breakthrough need be scheduled. The operating techniques of the reader system will be kept flexible to be compatible with the storage media of the Archival Mass Memory in Phase 2 of NEEDS.

W80-70256 **506-61-41**
Ames Research Center, Moffett Field, Calif.
INFRARED DETECTORS: FAR IR SENSORS
C. R. McCreight 415-965-6525

The objective is to develop advanced infrared detection systems for astronomical research. This program will provide the technology for new and more efficient data acquisition capability throughout the infrared (IR) spectrum (2-120 microns) for the low-background astronomical application. It will benefit the entire NASA IR astronomy program including future programs such as the Shuttle Infrared Telescope Facility (SIRTF) and the Space Telescope (ST), and the on-going ground-based, air-borne, and balloon-borne programs. Activities will include development of hybrid and monolithic arrays of high-sensitivity extrinsic silicon and germanium detectors, and improved discrete components for ultimate array applications. IR array expertise developed by the Department of Defense (DoD) and NASA will be used for wavelengths below 30 microns. New IR arrays will be developed for wavelengths beyond 30 microns. Activities will also include development of real-time data preprocessing/data compression electronics for use with the arrays in the astronomical application. IR detector expertise in industry will largely be used for design, fabrication, and preliminary testing of the arrays. Detailed evaluation of the arrays and electronics will be carried out at Ames and also at university facilities by interested IR astronomers. Realistic observational testing will be conducted using existing ground-based and airborne facilities. All work performed will be closely coordinated with related DoD and NASA activities.

W80-70257 **506-61-43**
Langley Research Center, Hampton, Va.
ULTRASENSITIVE DETECTORS: IR SENSORS
H. D. Hendricks 804-827-3418

The objective of this research is to develop and evaluate infrared ultrasensitive detectors that will provide a tenfold increase in usable data acquisition through improvements in sensitivity, resolution and increased spectral range for applications in aerospace missions such as remote sensing, environmental, atmospheric, geological, agricultural, pollution and planetary monitoring. The main thrusts are: (1) to develop monolithic indium antimonide detector arrays (1-5 micrometers) with on-chip signal processing and readout of infrared sensors utilizing charge coupled (CCD) technology, (2) to develop bi-level mercury cadmium telluride monolithic infrared arrays (8-30 micrometers) utilizing CCD technology, (3) to develop high quantum efficiency-multi-Giga-Hertz bandwidth photomixers for laser heterodyne spectrometry, (4) to develop calibration-compensated detector arrays for multi-spectral scanners, and (5) to develop and pursue on-chip signal processing technology for smart sensor concepts. Materials processing, device technology and fabrication technology will be developed to give the improved signal to noise ratios, increased resolution and broader spectral sensitivity. Techniques for calibrating and compensating detector arrays will be perfected.

W80-70258 **506-61-45**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INFRARED DETECTORS: INFRARED DETECTOR ARRAY DEVELOPMENT
John Wellman 213-354-7222

The objectives of this program are to develop infrared detector arrays and to demonstrate IR array instrument systems applicable to future NASA remote sensing missions. The development of IR arrays which utilize charge coupled device multiplexers to realize the advantages offered by large numbers of detectors is being actively pursued by a number of semiconductor manufacturers funded primarily by the military. While this technology offers the potential for several orders of magnitude increase in information return from future NASA missions it will require substantial development in order to satisfy the unique requirements of NASA missions. Primary among these is the need to acquire data with radiometric precision in an environment with low thermal background. Additional requirements include the need to produce images and moderate resolution spectra, high detectivity performance at intermediate temperatures of 50 to 100 K achievable with radiative coolers, long operating life, and survival in a radiation environment. The approach to the development of detector arrays consists of three interrelated activities: detector array requirements definition; detector technology development; and implementation of a detector test facility matched to the detector requirements. The requirements definition process consists of understanding the physical processes involved and synthesizing the generic mission-imposed requirements on detector performance. Technology development includes both the in-house analysis and engineering trade studies and subcontracted detector array design, fabrication, and test. The development of a strong test capability is a key part of this program. Because of the unique requirements mentioned earlier, much of the test capability possessed by industry fails to properly address the device parameters of concern to our missions. The results of our evaluation of detector performance will be factored into the development program at the contractor, and used in the development of instrument concepts.

W80-70259 **506-61-46**
Goddard Space Flight Center, Greenbelt, Md.
INFRARED DETECTORS: INFRARED SENSING SYSTEMS
Henry W. Prince 301-344-8101

The objective is to develop and flight test advanced infrared sensing systems to extend the performance capability of multispectral linear array (MLA) instruments that are expected to fly on future earth observation satellites. Current MLA sensor configurations employ silicon detector arrays which cover the spectra region from 0.4 to 1 micrometer. The effort under this RTOP will be directed towards development, flight test and evaluation of MLA sensor systems that operate in the 1-4 and 8-12 micrometer spectral regions. In the initial phase, the 8-12 micron region will be emphasized. The sensors will incorporate photovoltaic detectors directly coupled to Si CCD multiplexers. Sensor systems containing nominally 1000 cooled IR elements will be required and will be optimized for viewing terrestrial targets which have a high thermal background. Development of these sensor systems also requires supporting activities including definition of all reflective, wide-field angle optical systems, sensor modeling studies, and development of calibration techniques and test facilities among others. Infrared sensor systems that utilize self-scanned linear detector arrays that operate in the 8-12 micrometer spectral region will be developed and a laboratory and aircraft evaluation program will be conducted.

W80-70260 **506-61-53**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION LASERS: LASER SENSING TECHNOLOGY
S. L. Ocheltree 804-827-2791

The objective of this research is to investigate advanced laser and electro-optic sensor concepts, develop related systems technology and perform proof-of-concept field demonstrations for remote and in situ sensing of oceanographic and atmospheric properties. Sensor concepts to be investigated are laser backscatter and fluorescence techniques for marine and estuarine water parameter measurement; and continuously tunable infrared laser techniques for high resolution absorption and emission spectroscopy and measurement of low concentration atmospheric constituents. Critical technology for a Laser Heterodyne Spectrometer (LHS) Spacelab instrument will be developed.

W80-70261 **506-61-55**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH RESOLUTION LASERS: TECHNIQUES FOR ULTRAVIOLET-VISIBLE LASER REMOTE SENSING
J. B. Laudenslager 213-354-2259

The long term objective is a system level demonstration of the technology required for laser remote sensing of atmospheric species (in the ultraviolet and visible wavelength regions) from aircraft, balloon, and/or shuttle borne platforms. In order to meet this objective, laboratory experiments will be conducted using high resolution laser spectroscopy to determine the wavelengths at which UV laser remote sensing techniques can best be applied to specific atmospheric species. Laboratory development of UV lasers will also be carried out in order to produce laser sources with the required energy and pulse characteristics at the required wavelengths, spectral resolution, bandwidth, tunability, and repetition rate. Such UV laser sources are, at present, new technology items. Significant contributions have been made at JPL in developing new high energy UV laser sources under a related OAST RTOP in basic research. It is the purpose of this task to take this laser technology and apply it to the area of remote sensor systems. Active laser sensing in the UV-visible regions is an extremely sensitive and species specific method for detection of trace quantities of chemically important atoms and molecules in planetary atmospheres. Advantages of UV-visible laser sensing over IR laser sensing are improved transparency in the atmosphere, lower beam divergence for the shorter wavelengths, more efficient detectors, and sufficiently higher energy per photon to allow fluorescent scattering experiments. Laser fluorescent detection of atoms and molecules has been demonstrated in the laboratory to be a highly sensitive and specific analytical method. Recent developments of high energy UV gas excimer lasers at JPL as well as other laboratories, now make it possible to develop UV laser sensors to use in flight missions.

W80-70262 **506-61-56**
Goddard Space Flight Center, Greenbelt, Md.
HIGH RESOLUTION LASERS: LASER RANGING SYSTEM
J. J. Degnan 301-344-5020

The activities center on three principal elements: (1) the development of high performance components and an engineering model of a spaceborne laser ranging system capable of one to two cm accuracy; (2) the development and evaluation of tracking and control systems and techniques for accurate (one arcsecond) pointing of ground-based and space-based laser systems; and (3) the development of high performance components and a prototype of a high resolution (1MHz) submillimeter wave heterodyne spectrometer for spectroscopic applications. The technical approach in each of these areas is: (1) develop subnanosecond, flight qualified Nd:YAG lasers and 10 to 20 picosecond resolution optical ranging receivers; (2) using the computer controlled 1.2 meter telescope facility at GSFC, evaluate new angle tracking devices and software techniques; and (3) develop frequency stable, submillimeter wave (SMMW) lasers and 18 GHZ bandwidth heterodyne SMMW receivers.

W80-70263 **506-61-63**
Langley Research Center, Hampton, Va.
MULTIFUNCTION MICROWAVES: BROADBAND RADIOMETERS
R. F. Harrington 804-827-3631

The objective of this program is to develop the technology of and demonstrate the feasibility of an array of broadband microwave precision radiometers for simultaneous imaging of earth surface parameters on an all weather basis. The technical approach will be to improve the basic radiometers by improving the performance, resolution, bandwidth stability, and reliability of these devices through the development of low loss front end components, broadband devices with flat frequency response, microwave integrated circuit devices, broadband antenna feeds, etc. Broadband laboratory breadboard sets of improved microwave radiometer arrays with simultaneous imaging will be constructed, calibrated, and evaluated.

W80-70264 **506-61-65**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MULTIFUNCTION MICROWAVES: DEVELOPMENT OF SUBMILLIMETER WAVELENGTH COMPONENTS
J. W. Waters 213-354-3025

This program is to develop low noise, coherent, submillimeter wavelength receivers for multifunctional uses. The goal of the program is to provide the technological developments necessary for constructing low noise receivers operating up to 2000 GHz frequency (0.15 mm wavelength). These receivers will be of importance to the following areas of the space program in the time period beyond 1980: (1) terrestrial atmospheric observations from aircraft, balloon and earth orbit, (2) astronomical observations from aircraft and from earth orbit, (3) missions to planets and comets, and (4) supporting laboratory spectroscopy. Measurement needs of upper atmospheric research require that these recievers be developed as soon as possible. At present no adequate technique exists for global monitoring during both day and nighttime conditions of the chemically active species atomic O, OH, ClO, HCl, and others. Measurement of these species in the upper atmosphere is of recognized importance for assessing the extent to which man's technological activities may be affecting Earth's protective ozone layer. Calculations have shown, however, that these species can be measured, by observations of their emission spectra, with submillimeter receivers. In fact, for some of the species, submillimeter receivers may be the only means for their measurement. A satellite dedicated to upper atmospheric research is now being considered by NASA OSTA. Development of the submillimeter technology to meet measurement needs for the scientific objectives of this and following satellites is one goal of this RTOP. Four major component areas must be addressed: (1) development of efficient quasi-optical techniques for submillimeter receiver front ends; (2) development of techniques for efficient coupling of submillimeter radiation to nonlinear devices; (3) development of appropriate nonlinear devices capable of efficient operation at submillimeter wavelengths; and (4) development of local oscillator sources.

W80-70265 **506-61-66**
Goddard Space Flight Center, Greenbelt, Md.
MULTIFUNCTION MICROWAVES: MILLIMETER WAVE SYSTEMS
J. L. King 301-344-8949

The objective is to develop advanced technology and system concepts for passive microwave and millimeter wave sensing of the earth's environment. These sensors operate in selected bands over a frequency range from .6 to 225 GHz to measure parameters such as atmospheric water vapor, temperature, precipitation, sea surface temperature and wind speed, soil moisture, and snow water content, etc. These multifrequency and multifunction systems require advanced receiver and antenna technology over this entire spectral range. In the lower microwave region large aperture scanning beam and multibeam pushbroom antennas must be designed and developed to provide 1-10 km resolution and wide swath coverage (1000-2000 km) for meaningful space applications. The 1.4 GHz electrically scanned soil moisture radiometer array task will continue with more emphasis on waveguide and dipole array studies and development. This appears necessary because of the problems encountered in meeting the 28 MHz bandwidth requirements in the 10 meter microstrip array element breadboard which was undertaken in FY-79. The breadboard and test of a 10 meter waveguide array element will be completed in FY-80. The millimeter wave technology task should result in making the 183/225 GHz subharmonic mixers and local oscillators more reliable and capable of operation in aircraft environments. Advanced multichannel active/passive system studies will also be done to better define the 1 km IFOV next generation multichannel system.

W80-70266 **506-61-67**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED SYNTHETIC APERTURE RADAR TECHNOLOGY
K. Krishen 713-483-2846

The day/night, all weather, high resolution features of imaging radars provide an applications tool not available with any other

remote sensor. The present state-of-the-art capabilities of spaceborne imaging radars include single frequency, single polarization, and swath widths up to a 100km. The objective of the advanced synthetic aperture radar (ASAR) project is to develop and demonstrate technology for SAR systems with new functional and performance capabilities for missions planned for 1985-1995 period. Specifically, these capabilities include wider swath, precise amplitude calibration to 0.5db, and elevation imaging. The immediate objective of the ASAR will be to demonstrate the technology for wide-swath. A demonstration model of the ASAR will be developed with a wide-swath capability with at least twice the swatch available with the state-of-the-art aircraft SAR's. Electronic side scanning techniques will be investigated to generate the wide-swaths. Alternate design approaches will also be investigated. The system technology will be demonstrated by acquiring data with an end-to-end system from an aircraft. The goal of the system design will be such that it is directly scalable for space use. Areas not addressed in the initial design/development, such as elevation imaging will be identified and prioritized for future development.

W80-70267 **506-61-73**
Langley Research Center, Hampton, Va.
INSTRUMENT POINTING SYSTEMS: LANDMARK TRACKERS & ASPS TECHNOLOGY
C. R. Keckler 804-827-3917

The objectives are to develop and demonstrate techniques and systems capable of providing high accuracy pointing and stability (approximately 0.01 arcseconds) for experiments dedicated to stellar, solar, and terrestrial observations, as well as interplanetary investigation. To achieve these goals, new concepts, devices, and analyses are being pursued. These include the development of technique and systems for Earth feature identification, acquisition, and tracking as exemplified by the Video Landmark and Acquisition Tracking system; and new approaches to high accuracy pointing and stabilization of an experiment through the use of the Annular Suspension and Pointing System which utilizes magnetic suspension. Through these efforts; technology is being established to permit the achievement of mission objectives during the Shuttle era in a cost effective manner. System and component requirements as well as conceptual designs are defined through simulations. Effective system configurations, low cost system integration, multipurpose operation and utilization will be used to reduce systems costs while achieving required performance. Development of control software and hardware will be pursued and evaluated in the laboratory prior to their flight verification onboard the STS. These efforts are being directly coordinated with GSFC, JSC, MSFC, and JPL.

W80-70268 **506-61-75**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INSTRUMENT POINTING SYSTEMS: PRECISION POINTING AND TRACKING SYSTEM (PPTS)
L. F. McGlinchey 213-354-5199

The long range objective is to develop the technology for and demonstrate a spacecraft science platform PPTS that will meet the pointing requirements for high resolution imaging and spectroscopy experiments over a wide range of unmanned, planetary missions. In particular, the development is directed toward technology readiness of the Comet Rendezvous mission. The use of the PPTS will facilitate the attainment of NASA's long range goals of a tenfold increase in the acquisition of new and usable data and up to 50% decrease in cost for data processing. The approach used in meeting the objective of this program will be to design and develop a target body referenced, inertially stabilized platform which is capable of meeting the Comet Rendezvous pointing requirements. This design will be implemented in a single axis breadboard demonstration in order to provide technology readiness for the comet mission.

W80-70269 **506-61-81**
Ames Research Center, Moffett Field, Calif.
SENSOR COOLING: CRYOGENIC TECHNOLOGY FOR COOLING DETECTORS BELOW 10 KELVIN
J. W. Vorreiter 415-965-6525

The objective of this effort is to provide space-compatible technology for detectors requiring operating temperatures between 10 and 0.1 Kelvin. Liquid helium dewar technology will be advanced by investigations to develop low heat leak dewar supports and lightweight dewar construction techniques. Low temperature valves, as well as several new low-temperature insulation concepts, will also be designed and tested. Analytical investigations as to the behavior of helium in dewars in zero gravity will be undertaken. Low temperature refrigeration technology will be advanced with two separate space-compatible cooling techniques. A zero-gravity, helium-3 cryostat will be developed to cool detectors to a temperature of approximately 0.3 Kelvin as well as an adiabatic demagnetization refrigerator to cool detectors to a temperature of approximately 0.1 Kelvin. Surfaces contaminated to some degree will always be associated with optical surfaces cooled to this temperature range. By measuring the optical properties of these contaminated surfaces, the degree of contamination control required to meet acceptable surface properties will be identified.

W80-70270 **506-61-85**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SENSOR COOLING: ADVANCED REFRIGERATOR TECHNOLOGY
M. M. Saffren 213-354-2352

The objective of this program is to develop and demonstrate, no later than FY-85, prototype spacecraft cooling systems that can satisfy requirements of planetary and Earth applications missions planned beyond 1985, whose instruments and detectors must be cooled to low temperatures (2 - 80 K). During the past year, a JPL team issued a report which examines representative future missions, determines instrument cooling needs, identifies where available technology is inadequate to meet the needs, and recommends how the deficiencies can be remedied. It was found that requirements for at least ten planned instruments cannot be satisfied by existing technology. Candidate cooling approaches for these and similar systems are: (1) passive radiation (60 - 90 K); (2) magnetic refrigerators (mk - 250 K); (3) gas adsorption refrigerators (0.3 - 250 K); and (4) the novel mechanical refrigerators being developed at GSFC (40 - 80 K) and at JPL (4 K). The systems to be developed in this program will use a suitable combination of these refrigeration techniques. The applicability and availability of DOD flight refrigeration technology will also be assessed. The main deliverables will be tested engineering models of spacecraft cryogenic systems that satisfy mission requirements. The two major task activities are system design and development, and supporting research and technology. In the first of these, the engineering models will be designed, fabricated, and tested. In the second, fundamental knowledge will be applied to maximize refrigerator subsystem efficiency and reliability. At the completion of important milestones, JPL and NASA management personnel will review accomplishments and make decisions affecting subsequent task direction.

W80-70271 **506-61-86**
Goddard Space Flight Center, Greenbelt, Md.
SENSOR COOLING: CRYOGENICS FOR SPACEFLIGHT
Allan Sherman 301-344-5405

The overall objective of the cryogenics program is to provide low temperature technology which will be applicable to the large number of future missions that will require instrument cryogenic cooling. The program to accomplish these objectives includes technology development in the areas of mechanical coolers and solid cryogen coolers. The approach for the mechanical cooler R&T program is: (1) develop 3-5 year lifetime cooler technology models utilizing a linear drive, and noncontacting bearings and seals; and (2) develop the technology that is required for a one year lifetime cooler that could be utilized prior to the development of the 3-5 year coolers. The objectives of the solid cryogen program are lifetime/capacity enhancement for a given size, temperature range extension down to 8 K, and wider range of application for a given cooler system design. The program approach includes technology demonstration tests and systems development.

Spacecraft Systems Research and Technology

W80-70272 **506-62-16**
Goddard Space Flight Center, Greenbelt, Md.
POWER TECHNOLOGY ASSESSMENT
L. W. Slifer 301-344-8841

The objective is to collate the state-of-the-art, progress in ongoing research and development, and analysis of future requirements for the spacecraft power subsystem components for power conversion, energy storage and power processing to provide a basis for planning future R&D. This work emphasizes the exchange of technical information regarding progress and developments in the various power subsystem component areas, covering both government funded and manufacturers IR&D efforts. The assessment of state-of-the-art, R&D progress, and future requirements is accomplished by literature surveys, IR&D reviews, workshops, etc. The annual Battery Workshop is one of the major elements of this effort. Coordination of GSFC requirements into the overall NASA program and review of and consultation for NASA programs at other centers and DOD programs (Air Force) to assure maximum exchange of technology between agencies is also an important element of this RTOP.

W80-70273 **506-62-25**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AUTOMATED OPTICAL NAVIGATION
J. F. Jordan 213-354-7790

The objective of this work unit is to define, develop and demonstrate the technology readiness of ground automated systems for optical navigation, with significantly new and improved capabilities. The approach includes the analysis and assessment of anticipated automation requirements for spacecraft navigation and the prototype system development and demonstration of technology readiness for automated target-approach optical navigation. Long range goals are an increase in navigation accuracy and scientific data acquisition capability while reducing total costs. The Automated Optical Navigation system (AON) will extract navigation measurements from full-frame TV images, determine a best-estimate orbit, and compute a trajectory correction maneuver as a spacecraft approaches its intended target. Its use can reduce navigation costs of future Galileo-type missions by over $0.5 million per mission and future Voyager-type missions by over $0.25 million per mission and provides a technology base for the development of post-Galileo autonomous onboard navigation systems. A prototype system version, developed in FY-78 and FY-79 is being demonstrated in FY-79 using Voyager Jupiter encounter data. An automated advanced version will be demonstrated on the MODCOMP minicomputer at JPL during the Voyager Saturn encounter. A subsequent OSS operational system development plan is directed toward making the system available for initial use during the Galileo mission Jupiter orbital phase. The technical plan for the AON work unit is consistent with the 17 Feb. 1978 joint OAST/OSS Memorandum of Understanding, Development of Approach Optical Navigation-Automated Data Processing on the JPL Realtime Minicomputer System.

W80-70274 **506-62-32**
Lewis Research Center, Cleveland, Ohio.
AUXILIARY ELECTRIC PROPULSION FOR SPACECRAFT SYSTEMS
Robert C. Finke 216-433-6119
(506-22-62)

The overall program objective is to characterize and verify and 8-cm thruster subsystem design and to provide for transfer of the technology to the user community. The performance, lifetime, and interfaces of the 8-cm subsystem will be defined by a ground based program. This program will consist of tests of critical subsystem elements and full subsystem evaluation in both short and long term tests. The requirements and approaches for the flight test of two 8-cm subsystems will be defined. Data obtained from the flight test will be evaluated and reported. Efforts will be performed to provide timely information on the status and plans for the 8-cm program to the interested community. Work will be performed both by in-house and contracted efforts.

W80-70275 **506-62-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE STORABLE PROPULSION COMPONENTS TECHNOLOGY
D. L. Bond 213-354-5762
(525-71-05)

The objective of this effort is to provide the technology base for the rocket engine assembly and key feed system components for a space storable liquid propulsion system, and to assemble and test a F2-N2H4 system to verify the technology readiness of a space storable propulsion system. The approach is to continue the feed assembly components work, specifically long-term materials testing; evaluation of preprototype component tests; and procurement, test and integration of the feed assembly components for a demonstration system. A 60:1 expansion ratio rocket engine assembly will be tested and qualified for the demonstration system. This effort will culminate in the assembly and test of a demonstration system in mid FY-82.

Transportation Systems Research and Technology

W80-70276 **506-63-11**
Ames Research Center, Moffett Field, Calif.
SPACE SHUTTLE: CONFIGURATIONS AND AEROTHERMODYNAMICS
J. G. Marvin 415-965-5390

The objective is to provide the analytical and experimental support to the Shuttle Program Office as required for aerothermodynamic design, development, and verification of the shuttle orbiter, launch and ferry configurations and subsystems. The necessary expertise and facilities will be provided to support in-house and program-generated action items as required during the design, development and verification of the space shuttle.

W80-70277 **506-63-13**
Langley Research Center, Hampton, Va.
SPACE SHUTTLE DEVELOPMENT SUPPORT
B. Z. Henry 804-827-3911

This RTOP focuses Langley's expertise in configuration aerothermodynamics and operational flight mechanics on those concerns having greatest impact on successful development of the shuttle. The RTOP supports the shuttle program by (1) providing time in Langley ground-based facilities for direct OSTS/contractor-requested support, (2) continuing independent in-house shuttle technology and development studies, and (3) responding to specifically requested task-study areas from the program office at JSC. In addition, Langley will perform independent evaluations and assessments of the configurations and operational flight mechanics as necessary. This RTOP's program is coordinated with other NASA Centers and the phase C/D contractor through appropriate Program Office Engineering Coordination Panels at JSC.

W80-70278 **506-63-22**
Lewis Research Center, Cleveland, Ohio.
LOW-THRUST CHEMICAL PROPULSION SYSTEMS FOR EARTH ORBITING MSSIONS
Fred Teren 216-433-6897

The objectives are to identify and evaluate chemical propulsion system options and technology needs for future space missions, Low-thrust chemical propulsion systems for earth orbital missions will be studied. Candidate propellant combinations include hydrogen-oxygen or hydrocarbon-oxygen. Focus of the studies is on LEO-GEO orbit raising of large space systems.

Space Systems Technology Programs

W80-70279 **524-71-13**
Langley Research Center, Hampton, Va.
CASTS-COMPOSITES FOR ADVANCED SPACE TRANSPORTATION SYSTEMS
J. G. Davis, Jr. 804-827-2125

The broad objective is to increase the maximum operating temperature of resin-matrix composite materials for structural applications to 500 F to meet requirements for advanced space transportation systems and payloads. This objective will be achieved through a joint inhouse and aerospace industry contract effort which will include: (1) development and characterization of currently available polyimide resins and adhesives and new resin systems; (2) development of manufacturing and quality control procedures; (3) development of thermal structural design methods; and (4) design, fabrication and ground tests of components.

Space Systems Studies

W80-70280 **540-01-12**
Lewis Research Center, Cleveland, Ohio.
TECHNOLOGY OPTIONS ASSESSMENT
J. J. Ward 216-433-4000

The objectives of this effort are to identify satellite communications systems technology needs, assess technology limitations and development requirements, and develop recommendations for government-sponsored R&D activities. Key elements of this activity are: (1) interaction with other government agencies, industry, and NASA user-program offices to identify potential technology opportunities; (2) functional definition of technology performance parameters; (3) performance of tradeoff studies to identify technology development requirements; and (4) formulation of technology development scenarios and assessment of risk to aid establishment of development priorities.

W80-70281 **540-01-13**
Langley Research Center, Hampton, Va.
TECHNOLOGY NEEDS ASSESSMENT FOR ATMOSPHERIC OBSERVATION AND MEASUREMENT SYSTEMS
W. R. Hook 804-827-3666

Current work has developed generic techniques for generating Earth observational mission specifications and for generating corresponding spacecraft system concepts. Using these tools, an advanced atmospheric observation mission has been chosen to provide a focus to the R&D and technology demonstration activities. The objective is to identify and define technology requirements for the remote sensing and data management systems in an advanced atmospheric observatory, and to define potential programs for technology readiness demonstrations. The problem is approached via intense study of tropospheric science and applications requirements as outlined in OSTA's 'Research Objectives in Tropospheric Pollution' and the development of a tropospheric mission specification for the data acquisition and information management systems. The mission scope is then broadened to include other environmental and Earth resources applications. Work performed on a companion RTOP generates the corresponding spacecraft system concepts. The mission(s) and concept(s) are analyzed for the purpose of identifying technology development and demonstration requirements for the complete sensor-to-user information system designs.

W80-70282 **540-01-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STUDY OF SUBMILLIMETER WAVELENGTH RECEIVERS FOR SPACE ASTRONOMY
Paul N. Swanson 213-354-3273
(358-78-60; 506-18-35)

The submillimeter wavelength region between 300 and 2000 GHz is largely unexplored in astronomy because of the high opacity and variability of the earth's atmosphere. Our ability to orbit observatories above the earth's atmosphere will make this region of the spectrum accessable to astronomers in the near future. There are a few laboratories developing submillimeter receivers in the 300 GHz region for ground based and aircraft applications; however, little of this effort is directed toward space application and there is no concensus as to what is the best approach for submillimeter receivers in space. This study will evaluate the present and expected technology in submillimeter receivers and make recommendations as to which of the many approaches are best suited to eventual space use. A conceptual design for a first generation space instrument will be generated as part of this study. Applications of these receivers will be for initial submillimeter astronomical survey missions from the shuttle and eventually in a dedicated observatory with an antenna of at least 10 m in diameter.

W80-70283 **540-02-11**
Ames Research Center, Moffett Field, Calif.
SPACE SYSTEM STUDIES - INFORMATION AND SPACECRAFT SYSTEMS
J. P. Murphy 415-965-6520
(358-41-06; 358-78-60)

The objectives are to identify and evaluate the technology requirements of advanced system candidates, investigate future space mission alternatives, assess the effects of technology advances, and provide a data base to support technology program selection and program planning. The approach is to conduct studies related to these objectives on potential mission concepts identified by OSS in Infrared Astronomy and Planetary Probes. In FY-80, work will be completed on two studies started in FY-79: (1) a technology assessment and conceptual design study for the Large Ambient Deployable IR Telescope; and (2) a technology assessment and technology plan development study for the Titan Probe.

W80-70284 **540-03-12**
Lewis Research Center, Cleveland, Ohio.
LOW-THRUST PROPULSION FOR EARTH ORBITING MISSIONS
Fred Teren 216-433-6897

The objective is to identify and evaluate low thrust propulsion system options and technology needs for future space missions. Electric and low thrust chemical propulsion systems for earth orbital missions will be studied. Principal focus is on LEO-GEO orbit raising.

W80-70285 **540-03-13**
Langley Research Center, Hampton, Va.
TECHNOLOGY REQUIREMENTS OF INTEGRATED EARTH-TO-GEOSYNCHRONOUS SPACE TRANSPORTATION SYSTEMS
B. Z. Henry 804-827-3911

The objective of this study is to identify and evaluate the technology required for the design and operation of advanced systems capable of meeting the goals of economical transportation within the Earth-Moon sphere of influence in the postshuttle timeframe. The intent is to analyze potentially attractive concepts which build upon the technology base developed for the Space Shuttle Program utilizing projected advances in the areas of materials, structural design, propulsion, aerothermodynamics, design interaction and others. Definition of approaches to advanced system design and a detailed examination of the relative impact of assumptions as to achievable levels of various technologies offer a suitable means of identifying those technologies which are crucial as well as those most cost effective; this identification will be a primary output of the effort. An inherent characteristic of any such advanced system is that it offers clear and significant cost/capability advantages relative to current systems. Programs to provide solutions to key technology issues will be designed based on the results of these studies. The activity will be pursued through a series of contractual system studies, technology planning, methodology development studies, and selected inhouse analyses, and an intercenter working group as required.

W80-70286 **540-03-16**
Goddard Space Flight Center, Greenbelt, Md.
GROUND DATA PROCESSING TECHNOLOGY OPTIONS ASSESSMENT FOR MISSIONS OF THE 1985-1990 TIME FRAME
J. J. Gitelman 301-344-7889

Previous history in NASA research and development and operational missions has shown that these systems were designed from space looking down, i.e., design a space sensor that produces data, get these data to the experimenters/users and finally attack the problem of translating these data to the information products required. This RTOP will lead to a ground up design process for new missions of the 1985-1990 time frame, i.e., define the information products that are required and then design the space and ground data/information delivery system to obtain and produce the data/information necessary to derive the final information products. New technological approaches and techniques to efficiently perform the data to information conversion and data dissemination will be identified.

Information Systems Technology

W80-70287 **541-01-13**
Langley Research Center, Hampton, Va.
NASA END-TO-END DATA SYSTEM: INFORMATION ADAPTIVE SYSTEM
William M. Howle 804-827-3535

The primary objective of the information adaptive activity (IAS) is to develop and demonstrate an onboard spacecraft data system which adaptively controls and processes sensor data. The IAS will interface directly with Earth resources and environmental monitoring sensors to provide onboard data control, formatting, calibration, preprocessing, data set selection and feature classification. The key hardware and software components required to implement a ground demonstration of the IAS will be developed and a laboratory brassboard of the IAS will be demonstrated and evaluated in a simulated real time data environment. An IAS system design study contract will augment planned inhouse R and D during the system design phase of the program. Key IAS components identified and specified during the system design phase will be developed under contract. The IAS is an essential element of the NASA/OAST NASA end-to-end data system program and will provide a significant contribution in attaining the goals of this program.

W80-70288 **541-01-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NASA END-TO-END DATA SYSTEMS: MODULAR DATA TRANSPORT SYSTEM
R. Nixon 213-354-4268

The objective of this task is to develop and demonstrate key system elements of a Modular Data Transport System (MDTS) which forms a part of the overall NASA End-To-End Data System (NEEDS) Program. The MDTS has been defined to include the onboard data handling and control system; channel coding and formatting protocols; ground data transportation links; and data capture, staging and validation prior to delivery to a user data base. Communication technology has been explicitly excluded. This task is being conducted in cooperation with the GSFC and builds upon,the technology developed as a part of the NEEDS Phase I Program. Specifically, this RTOP will include: (1) participation with other NASA Centers on NEEDS teams to define MDTS requirements; (2) design support to the NEEDS phase I digital data system to ensure the incorporation of MDTS requirements; (3) the development and specification of formatting and coding requirements for the transporting of data from the sensor through a ground data staging area; (4) the breadboard demonstration of onboard data handling and control hardware, including data compression; (5) the development of a demonstration test bed to implement a series of end-to-end of the MDTS; (6) participation in an integrated NEEDS systems demo which will include interfacing the MDTS to the Information Adaptive System (IAS) and Data Base Management (DBM) system; and (7) provide technical support to GSFC in the overall system engineering of NEEDS, and provide the leadership for the Intercenter MDTS team activities.

W80-70289 **541-01-16**
Goddard Space Flight Center, Greenbelt, Md.
NASA END-TO-END DATA SYSTEM (NEEDS): PHASE 2
R. D. Price 301-344-7377

The NASA End-to-End Data System (NEEDS) extends from the detection of an event by a sensor to the output of data to the user and includes the planning and feedback of conditioning to the sensor for event detection. The objective of the NEEDS Program is to significantly increase the effectiveness and efficiency of this system through the development of advanced technologies and techniques. The broad objectives of Phase 2 are to develop and demonstrate subsystems, and to define data systems configurations, operational procedures, and data handling techniques which will enable real time data management. The approach will be to conduct a continuing systems analysis to guide and evaluate the program, to develop new subsystems and operations concepts, and to integrate and test-demonstrate at the brassboard level the composite system. The Goddard Space Flight Center (GSFC), as lead center on this program, has responsibility for overall program management and coordination, and leads or participates in most of the technology development. More specifically the technical approach has been divided into eight tasks: (1) systems level support, including program management, coordination and trade off studies analysis, (2) development of advanced data system concepts, (3) information adaptive systems algorithm development, (4) onboard image registration study, (5) modular data transport system development, (6) data base management system software development, (7) parallel processor development, and (8) study of distribution control concepts.

W80-70290 **541-01-19**
Marshall Space Flight Center, Huntsville, Ala.
NASA END-TO-END DATA SYSTEM (NEEDS) - DATA BASE MANAGEMENT/ARCHIVAL MASS MEMORY
Leonard S. Yarbrough 205-453-1023

The objectives are to develop and demonstrate: (1) a ground data base management system (DBMS) that can accept large volumes of space data at high data rates and provide data to single users or multiple users simultaneously, at reduced access times; and (2) an operational optical archival mass memory (AMM) system having on-line archival-quality storage/retrieval capacity to 10 to the 13th power bits. Both systems have been identified as integral parts of the NASA End-to-End Data Systems Program. The DBMS objective will be fulfilled by a mini-micro-processor controlled system that will maintain high throughput rates by the use of parallel data transfer modular multiported auxiliary storage devices, undirectional flow of high volumes of data, and innovative configuration and software design. Development of a prototype optical permanent-record storage system to read/replicate will fulfill the second objective. In this RTOP, programmatic changes were incorporated in the AMM task to allow the rapidly developing area of optical disks to be more seriously considered as a recording technique. Specifications have been written for an AMM that will maximize the performance/cost ratio. Upon successful completion, the AMM will be delivered and integrated into an existing DBM system and demonstrated.

W80-70291 **541-02-12**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS SATELLITE COMPONENT AND SUBSYSTEM TECHNOLOGY
R. E. Alexovich 216-433-8490

The objective is to advance the state-of-the-art of communications satellite components and subsystems. To achieve this objective, research and advanced development, enabling technology programs will be undertaken on solid state amplifiers spacecraft switches, space and ground antennas, spacecraft transponders, tube-type amplifiers and their associated power processors, and low-cost earth terminals. Spacecraft transponder development will include research and investigations on low noise

amplifiers, multiplexers, filters, high power rf switches, solid state drivers, and other components. Research will be performed and analytical models and techniques will be developed for multifrequency, multibeam antennas and communications network architecture and protocols.

W80-70292 **541-02-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EARTH SATELLITE COMMUNICATION ANTENNA DEVELOPMENT
P. W. Cramer 213-354-3509

The objective is the development of multiple beam antennas, with low sidelobes and good cross polarization characteristics to enable communications satellites to make more efficient use of the geosynchronous orbit and available frequency allocations. The developments are applicable in the frequency range from UHF to Ka Band. The technical approach is to develop the analytical techniques for antenna improvement, verify the techniques with computer simulations, and perform proof of concept with demonstrations. Efficient multibeam measurement techniques are developed to enable easier evaluation. Specific attention is directed to multibeam antenna feed array development, reflector system performance improvement studies, and the application of predictive models to antenna design tradeoff studies. The multibeam antenna feed development consists of single-element, cluster-of-elements and plane wave array feed designs for reflector antennas. The reflector system performance improvement studies consist of shaped, near-field, and bifocal designs for offset dual reflector systems. The quantitative technical objectives include multibeam antenna system sidelobe and cross polarization suppression to -30 db minimum.

Spacecraft Systems Technology (RSS)

W80-70293 **542-01-13**
Langley Research Center, Hampton, Va.
SPACE STRUCTURES SYSTEMS TECHNOLOGY
R. L. James 804-827-4606

Systems level activities will be conducted to define the multidisciplinary technology requirements for future large space antenna and platform systems. Promising structural concepts and associated technology will be developed and tested to meet the needs of the NASA missions of the mid-to late 1980's. The development activities will include the evaluation of erectable and deployable structures and the assembly thereof utilizing composites and other advanced materials. The supporting technology disciplines of distributed control techniques and their interaction with the structure, electronic sensor and signal distribution methods, power distribution networks, surface measurements and control techniques, and the utilization of interactive design and analytical programs will be fully explored and advanced by this program effort. Further, the antenna and platform requirements in the 1985 to 2000 time period will be studied so that technology developed for the near term missions can be cost effectively extended for larger and more complicated systems. The Langley Research Center has been designated as the lead center for the Space Structures Systems Technology Program, and the program will be managed by the Large Space Systems Technology (LSST) Program Office at Langley. The LSST Program Office will plan and coordinate the technology development tasks among the participating NASA centers.

W80-70294 **542-02-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE STORABLE PROPULSION SYSTEMS TECHNOLOGY
D. L. Bond 213-354-5762

The overall objective of this effort is to demonstrate technology readiness of a complete spacecraft-sized, flight-weight fluorine-hydrazine (F2-N2H4) propulsion system by mid FY-82, using both past and ongoing individual component and system-related developments. The approach is to conduct a demonstration that consists of a hot-fire test of the complete system to a preselected duty cycle that will simulate a typical application. The system level design effort initiated during FY-77 will continue through the critical design review to be held in mid FY-80. The structural detail design will be completed in FY-80. The system level thermal verification test plan will be completed in early FY-80 and assembly and testing in the thermal vacuum simulator will be completed in FY-81. System procurements and assembly will be accomplished in FY-81, culminating in the full system demonstration test in FY-82. The feed assembly components and rocket engine assembly to be used in this demonstration system are being designed and fabricated under RTOP 506-62-35.

W80-70295 **542-03-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DEVELOPMENT OF A SHUTTLE FLIGHT EXPERIMENT: DROP DYNAMICS MODULE
T. G. Wang 213-354-6331

The principal objective of this RTOP is to design, fabricate, and test an acoustic positioning and manipulation module for Spacelab and to utilize it to perform the experiment Dynamics of Rotating and Oscillating Drops as part of the NASA Physics and Chemistry in Space Program on an early shuttle/spacelab flight. The module is scheduled to be ready for the ESA-NASA joint Spacelab mission, and will be available for Spacelab flights thereafter. This acoustic positioning and manipulation module will allow us to utilize the unique zero-G environment provided by a shuttle/spacelab flight to perform drop dynamics experiments that are impossible to perform in a gravitational field. Examples are: (1) study experimentally the problems first proposed by Newton and never satisfactorily studied of equilibrium figures and the bifurcation processes of a rotating spheroid, and (2) understand the fission and fusion processes in drops that are also applicable to meteorology and nuclear physics. The scope of this work is threefold: first, to determine the maximum capability of this facility within the constraints of money and schedule through consultation with the scientific community and investigators; second to fabricate a flight unit; and third, to perform the experiment Dynamics of Rotating and Oscillating Drops as part of the NASA Physics and Chemistry in Space Program. The scientific community will be invited to participate in experiments informally through international symposia and colloquia. Some scientists will participate with JPL as science associates and consultants.

W80-70296 **542-03-02**
Marshall Space Flight Center, Huntsville, Ala.
DEVELOPMENT OF AN INDUCED ENVIRONMENT CONTAMINATION MONITOR (IECM)
Edgar R. Miller 205-453-5130

The broad objectives of the induced environment contamination monitor (IECM) are to conduct an in depth survey of potential contamination to experiments from the induced environment in and around the STS on early flights (OFT, spacelab). A set of contamination-measuring instruments will be developed and built. These instruments will be integrated into a self-contained flight package to verify the specified requirements (in Volume X of JSC Document 0770), to identify contamination sources, and to detect and monitor environment contamination during all mission phases, including delivery, deployment, retrieval, and landing a free-flying payload.

W80-70297 **542-03-04**
Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE OPERATIONAL FLIGHT TEST OF THE SOLAR ELECTRIC PROPULSION SOLAR ARRAY
J. Bridges 205-453-2336

The objective of this RTOP is to provide overall demonstration of the availability of advanced Solar Array Technology by flight testing the Solar Electric Propulsion (SEP) Solar Array as an experiment on Shuttle. Demonstrating that the array will deploy and retract in a space environment and establishing its dynamic characteristics are objectives which are particularly important. The approach consists of four basic steps: (1) define, through study and analysis, the requirements, criteria and conceptual design from the Solar Array System experiment (completed

FY-77); (2) perform a detailed design, build, and test the flight array experiment; (3) install and fly the solar array experiment on Shuttle; and (4) evaluate flight results after return to earth.

W80-70298 **542-03-07**
Goddard Space Flight Center, Greenbelt, Md.
THERMAL CANISTER EXPERIMENT
Stanford Ollendorf 301-344-5668

The broad project objectives are to demonstrate the performance in space of an Experiment Thermal Control Canister using heat pipes. The primary specific objectives are: To design, fabricate, and test a Thermal Canister 1m x 1m x 3m weighing 160kg., which when flown aboard space shuttle on an OFT mission will verify the ability of a system of heat pipes to provide thermal control, within the following limits: maintain canister wall temperature level to 15 C + or - 3 C while dissipating 100 watts at maximum flux conditions (full sun) to 400 watts at minimum flux (earth oriented) conditions. In addition, secondary objectives are: To verify performance of the canister at off nominal design points as: (1) operation over a temperature range of 5 deg to 25 deg and determination of maximum heat rejection and control band at these points; (2) maintenance of + or - 10 C control when operating under passive control. The general design approach is to incorporate elements of Thermal Control Technology, such as fixed conductance and variable conductance heat pipes into a canister with radiators for controlling the temperature of simulated instruments and other suitable experiments.

W80-70299 **542-03-12**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PROPULSION CONTAMINATION EFFECTS MODULE - (PCEM) SPACEFLIGHT EXPERIMENT FACILITY
L. F. Molinari 213-354-4515

The Propulsion Contamination Effects Module (PCEM) Facility Project objectives for fiscal year 1980 are to complete the flight configuration design and to conduct a CDR and a second safety review. The PCEM will be used in tests to measure such rocket thruster exhaust plume characteristics as core flow and back flow efflux (mass and constituents), electrical charge buildup, impingement forces, and heating rates in a series of spaceflight experiments to be flown in the payload bay of the space shuttle orbiter. The PCEM Facility will be designed and fabricated to initially accommodate a 110-N (25-lbf) monopropellant hydrazine propulsion system provided by MSFC. Design modification kits will enable the PCEM Facility to subsequently accommodate other propulsion systems including a 3870-N (870-lbf) N2O4/MMH liquid bipropellant system (JPL), 0.0044-N (0.001-lbf) and 0.13-N (0.03-lbf) ion drive engines (LeRC), a 4450-N (1000-lbf) solid rocket motor (JPL), and a 2225-to-4450-N (500-to-1000-lbf) O2H2 liquid bipropellant system (LeRC). The facility will be designed to include the basic science instrumentation systems for measurement of plume parameters of the various types of propulsion systems. The flight experiments and the reports will be the final phase of the project. The payload category of the PCEM Facility is Attached Experiment, Space Available, Class C (AE/SA-C). The FY-80 approach toward achievement of the objective is to evolve the FY-79 preliminary design to include detail designs of the facility which will be the basis for the CDR. This will include design, design analysis, thermal analysis, stress analysis, and systems analysis. This design will encompass the facility structure, instrumentation, control/data acquisition, system, and support equipment. The design will be evaluated for conformance to safety requirements and documentation prepared for the safety review.

W80-70300 **542-03-13**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACELAB 2 SUPERFLUID HELIUM EXPERIMENT
G. Lagomarsini 213-354-5110

An experiment to investigate the properties of superfluid helium in zero gravity is proposed for flight on Spacelab 2 in early 1982. The experiment will determine the mechanical and thermal properties of superfluid helium in sufficient detail to enable the design of high performance, space-qualified superfluid cryogen systems. A companion experiment will study the properties of low velocity capillary waves in thin films of superfluid helium. These waves cannot be observed in the earth's gravity. Their study will increase scientific understanding of the interaction of normal and superfluid helium. The experiment will consist of an instrumented cryostat, an experiment package mounted inside the cryostat, and an electronics control and data processing electronics package. It will be mounted on a spacelab pallet, and will interface with the spacelab command and data management system. Interactive control with experimenters on the ground will permit optimization of scientific results by real time modification of experimental conditions and parameters.

W80-70301 **542-03-14**
Langley Research Center, Hampton, Va.
FILE II FLIGHT EXPERIMENT
W. E. Sivertson 804-827-3666

The objective is to develop an advanced feature identification and location experiment (FILE 2). New instrumentation will be produced for flight and technology evaluation aboard a shuttle payload flight in the 1981 - 1982 time period. This experiment will provide in situ test data required to develop an autonomous cloud detector, and will enhance SR&T efforts to provide new user ready technology in information management, pointing, tracking, navigation, and automations. The FILE 2 instrument, as proposed, will make optimum use of existing FILE 1 flight, protoflight, and breadboard hardware. The FILE 2 instrument will classify image scene content into five categories--vegetation, bare Earth, water, clouds, and snow and ice. This classification is based on radiance ratios of spectral signatures in the 0.65, 0.85, and 1.55 micron bands. Results from this effort will not only expand FILE classification technology by adding a third spectral band, but will focus on providing new knowledge required for producing a cloud detection instrument for future missions. Fabrication of a flight instrument will be initiated under contract. This instrument will utilize FILE 1 hardware--both flight and protytype equipment. A third camera will be added at 1.55 micrometer and logic algorithms and instrument turns-on command will be modified. Some effort will be directed to simulation and instrument set up and evolution using results obtained from the FILE 1 flight test.

W80-70302 **542-03-20**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE CALIBRATION OF SOLAR CELLS
L. B. Sidwell 213-354-5489

The objective of this program is to take advantage of the space environment of spacelab to correlate solar cell calibration data with those obtained from balloon flights. The spacelab program will provide the opportunity to validate existing calibration procedures and to determine the most cost effective way of accomplishing solar cell calibration. Fabrication of the experiment and system, and environmental testing will be started and completed in FY-80. During the last quarter of FY-80 the experiment will be ready for integration with Spacelab. Candidate test solar cell specimens will be selected in advance of the Spacelab flight, with similar solar cells to be flown on a high altitude balloon flight calibration experiment for comparative analysis. The RT funded balloon flight will take place during the same time frame as the Spacelab flight. On completion of both flights, the RT funded data reduction will begin with completion and final report expected 180 days after data availability.

W80-70303 **542-03-27**
Marshall Space Flight Center, Huntsville, Ala.
TRIBOLOGICAL EXPERIMENTS IN ZERO GRAVITY
R. L. Gause 205-453-1500

The following paragraphs summarize the technical scope of two tribological experiments selected for development for flight on Spacelab. The experiment entitled 'Tribological studies of fluid lubricated journal bearings in zero gravity', proposes the operation of a conventional journal bearing and of a journal bearing which utilizes ferrolubricants. Basic behavior characteristics of journal bearings operating in zero gravity should be provided by this experiment. The experiment entitled, 'Wetting, spreading and operating characteristics of bearing lubricant in a zero gravity environment', will monitor the wetting process for selected

lubricant-surface combinations and provide an understanding of the mechanism of properly maintaining lubricant films and the effect of surface wettability on bearing performance and life in a space environment.

W80-70304 **542-03-29**
Marshall Space Flight Center, Huntsville, Ala.
IN-ORBIT CALIBRATION OF MESA LOW-G ACCELEROMETER
Robert F. Harwell 205-453-2338

The objective of the miniature electrostatic accelerometer (MESA) experiment is to evaluate the accelerometer's performance in a low-g environment and to compare the results with ground based data. The proposed program will thus provide information regarding Spacelab 2 vehicle dynamics and its capability as a low-g test facility, and will define the Space Shuttle's acceleration environment. It is proposed to utilize a flight qualified MESA low-g accelerometer with minor modifications to provide three-axis, acceleration measurement capability. In-orbit calibration will be accomplished by using a slowly rotating table from which a large number of different acceleration levels can be produced by changing rotation speed. Vehicle angular rates and orbital drag are frequency modulated and may be easily separated from the table's steady-state, centripetal acceleration. The proposed experiment involves a minimum of development effort and is considered low risk because of the extensive operational flight and qualification history of the MESA.

W80-70305 **542-03-30**
Langley Research Center, Hampton, Va.
SEMICONDUCTOR MATERIALS GROWTH IN LOW G ENVIRONMENT
R. K. Crouch 804-827-3661

The objective is to utilize the microgravity environment available on STS in such a way as to eliminate or minimize the segregation of constituents and to minimize the influences of thermal convection on the growth of semiconductor materials usable in making infrared detectors. Studies in a low g environment will optimize growth procedures and analysis will include detailed comparison of space grown and earth grown crystals to provide data on important growth parameters needed to improve state-of-the-art earth based processing.

W80-70306 **542-03-32**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SHUTTLE EXPERIMENT TO DEMONSTRATE READINESS OF MICROWAVE LIMB SOUNDING TECHNOLOGY FOR UPPER ATMOSPHERIC MEASUREMENTS FROM SPACE
J. W. Waters 213-354-3025

The objective is to demonstrate the readiness of microwave limb sounding technology for upper atmospheric measurements from space. This development has been recommended with high priority both by the NASA/OSS Upper Atmosphere Research Satellites (UARS) Science Working Group and by the NASA/OSTA Applications Review Panel on High Resolution Passive Microwave Satellites. Theoretical calculations of signal strengths have shown that with recent technological developments the following upper atmospheric parameters can be measured with useful accuracy during both day and night: winds, temperature, magnetic field, O3, H2O, O2, CO, and ClO. Anticipated advances in technology at submillimeter wavelengths will allow many additional measurements including atomic O, OH, HCl, NO, NO2, HO2. For certain of these species (e.g., OH, atomic O, HCl) submillimeter limb sounding appears to be the only way to obtain remote measurements during both day and night. A definition phase study, now underway, will be completed in early FY-80. Results of this study will include: (1) which spectral band(s) in the millimeter/submillimeter spectral range will be used, (2) the required instrumentation, and (3) an experiment implementation plan. The experiment will be responsive to the development needs of the NASA/OSTA Upper Atmosphere Research Program and collaboration with that Program Office will be explored. Following completion of the definition phase, hardware development will be initiated. The hardware will include an instrument for measurements from the Space Shuttle. It is anticipated that a shuttle-provided experiment pointing mount will be used. In order to achieve minimum cost the instrument will initially have selected measurements and limited scope, but will be modularly designed to allow flexibility for more extended measurements in the future.

W80-70307 **542-04-13**
Langley Research Center, Hampton, Va.
LONG DURATION EXPOSURE FACILITY
R. D. English 804-827-3704

The broad LDEF project objectives are the following; (1) to develop LDEF, a simple, low-cost, free-flying facility for performing long duration technology and other experiments in the space environment using the STS; (2) to develop a first set of experiments for the facility and, by the performance of these experiments, obtain valuable technological data and demonstrate the unique shuttle/LDEF capabilities and features; and (3) to broaden the STS user community by providing a simple low cost approach to integrate and operate a large number of OAST and other unmanned long duration experiments via the STS. The LDEF is a reusable, unmanned, low-cost, free-cost, flying structure on which many different experiments can be mounted. The facility will be delivered to Earth orbit by the shuttle. After an extended period in orbit, the facility will be retrieved on a subsequent shuttle flight and returned to Earth for experiment analysis. Many of the experiments being considered for the LDEF are completely passive with the active data measurements being made in the laboratory after the experiments are returned.

W80-70308 **542-05-01**
Lewis Research Center, Cleveland, Ohio.
FLIGHT TEST OF AN ION AUXILIARY PROPULSION SYSTEM (IAPS)
Rodney M. Knight 216-433-5183

The objective is to conduct in-situ tests of a one millipound mercury-ion thruster auxiliary propulsion system over are representative duty cycle and time period, to acquire engineering design information by which to determine the systems compatibility with host spacecraft, and to demonstrate to potential users the technology readiness of mercury-ion thruster systems for auxiliary propulsion applications aboard operational spacecraft. The experiment will be flown as part of the USAF/Space Test Project P80-1 (Teal Ruby) spacecraft.

Transportation Systems Technology

W80-70309 **543-01-01**
Lyndon B. Johnson Space Center, Houston, Tex.
OEX (ORBITER EXPERIMENTS) PROJECT SUPPORT
P. D. Gerke 713-483-3987

The OEX Program has been initiated in support of OAST to utilize the space shuttles as a research vehicle. The program objective is to collect data in the technology disciplines that will augment the research and technology base for future spacecraft design. The data will be collected by utilizing the currently planned DFI configuration, by modifications and/or augmentations to the present OFT baseline instrumentation and by development of experiments beyond the DFI capabilities for flight on the Orbiter. The primary goal of this activity is a more efficient utilization of the STS capabilities to obtain data with which to advance spacecraft technology. This RTOP includes the effort associated with project initiation, project support, experiment development initiation, experiment compatibility assessments, experiment integration activities and integration hardware development initiation. The experiment development effort is the subject of additional RTOP's from the appropriate NASA Centers.

W80-70310 **543-01-02**
Langley Research Center, Hampton, Va.
SHUTTLE ENTRY AIR DATA SYSTEM (SEADS)
P. M. Siemers 804-827-2984

The objective is to extend the knowledge of aerodynamics, aerothermodynamics, and basic fluid mechanics into flow

regimes previously inaccessible to the investigator through extraction of flight data during routine operation of the shuttle orbiter. This knowledge will be applied to verify and increase the reliability of sophisticated computational prediction codes; to develop procedures to extrapolate wind tunnel data to flight conditions; to improve the performance and operational capability of the STS; and to provide a data base for studies of future aeronautical and aerospace vehicles. The design, development, and calibration of the shuttle entry air data system will be accomplished through in-house (LaRC) analysis and test programs, and contracted studies. A retrofitted intrumented nose cap incorporating the shuttle entry air data system will obtain flight air data during each orbiter flight. These data, in conjunction with intertial data, development flight instrumentation data, and data obtained by specialized instrumentation packages will be utilized to verify aerodynamics and aerothermodynamics performance as well as resolve many basic fluid mechanic questions.

W80-70311 **543-01-03**
Lyndon B. Johnson Space Center, Houston, Tex.
ACIP (AERODYNAMIC COEFFICIENT IDENTIFICATION PACKAGE)
Ernest L. Weeks 713-483-4661

The objectives of the proposed system are twofold: (1) acquisition of high quality flight data for post-flight aerodynamic coefficient estimation; and (2) provide flight dynamic state variable data which would support other technology areas such as aerothermal or structural dynamics. The proposed experiment consists of an instrumentation package and baseline Orbiter data which will provide flight mechanics data for the determination of aerodynamic coefficients from Orbiter flight data. The data from the system will also provide appropriate reference conditions for other aerothermal and flight dynamics experiments. This experiment would require power, time correlation, environmental support and a suitable structural location from the orbiter.

W80-70312 **543-01-04**
Langley Research Center, Hampton, Va.
SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING (SILTS)
J. C. Dunavant 804-827-3984

The objective of this activity is to extend the knowledge of the basic aerothermodynamics of leeside flow fields and heat transfer on large lifing vehicles into flow regimes which are inaccessible to investigations in ground facilities through sensing of leeside surface temperatures during shuttle orbiter entry with an infrared scanner. These data will permit development of improved leeside flow field and heat transfer prediction techniques which are required to reduce considerably the weight and cost of thermal protection systems on the leeside of future space vehicles. This experiment utilizes a highly developed infrared scanner and recording system which will be qualified for the severe ascent environment in a development program at the Langley Research Center. The instrumentation and supporting equipment will be installed in a Langley manufactured engineering test model and tested at the Langley Research Center; the flight structural pod, exclusive of the dome will be manufactured by the shuttle orbiter contractor; and the experiment will be installed in Orbiter 102 at KSC. The SILTS experiment will be flown on a number of early orbiter flights.

W80-70313 **543-01-05**
Ames Research Center, Moffett Field, Calif.
INFRARED IMAGERY OF SHUTTLE
B. L. Swenson 415-965-5263

The objective is to design, develop, and conduct an experiment to be used in conjunction with the first orbital flights of shuttle. The experiment is part of the orbiter experiments program (OEX) and will obtain measurements of surface temperature of the lower and side surfaces of Orbiter by means of remote high resolution infrared imagery. This imagery is obtained on board the C-141 Kuiper Airborne Ovservatory (KAO). The experimental equipment to be developed consists of an acquisition telescope and appropriate servo system, cryogenically cooled focal plane and detector array, and a data handling and storage system.

W80-70314 **543-01-06**
Ames Research Center, Moffett Field, Calif.
OEX THERMAL PROTECTION EXPERIMENTS
H. K. Larson 415-965-5369

The overall objective of these experiments is to obtain a better understanding of TPS reentry heating effects that may permit TPS cost and weight reductions for shuttle and advanced space transportation systems. Two separate experiments will be flown as test panels or tiles replacing baseline TPS on the shuttle orbiter during orbital flight tests (OFT) and operational flights. These experiments will take advantage of the real entry heating environment that cannot be fully simulated in ground facilities to demonstrate advanced TPS materials for possible orbiter retrofit and to investigate TPS heating effects. Temperature data will be obtained with existing and follow-on orbiter instrumentation. Baseline TPS procedures and tooling will be used, and none of the experiments will impact orbiter operations. The experiment will be designed and fabricated by both inhouse and contract efforts, and experiments hardware will be provided as GFE.

W80-70315 **543-01-07**
Langley Research Center, Hampton, Va.
SHUTTLE UPPER ATMOSPHERE MASS SPECTROMETER (SUMS)
R. C. Blanchard 804-827-3786

The primary technological objectives are toprovide flight data for advances in the prediction of aerodynamic behavior throughout the high-speed flight regime, including the free molecular flow and the transition into the hypersonic continuum. This objective will be achieved through shuttle orbiter flight instrumentation, including a shuttle upper atmosphere mass spectrometer (SUMS). The specific objective of the SUMS system is to provide in situ high altitude atmospheric data, primarily neutral atmospheric mass density. A spare Viking flight-qualified mass spectrometer will be modified to provide atmospheric data in the high hypersonic flight regime. These data, coupled with data from other proposed experiment systems, will provide aerodynamic information on a winged entry vehicle in flight regimes heretofore unobtainable and will augment ground-based test facilities. In addition, experiment results on the shuttle will provide a benchmark from which to evaluate additional entry technology research. The experiment data analysis system will be tested as much as possible with existing flight and environment data from OFT and other missions. The design, construction, and system tests of the prototype and the supporting analysis on the SUMS system design and implementation will bring the experiment to the flight readiness state.

Energy Programs

W80-70316 **776-91-19**
Marshall Space Flight Center, Huntsville, Ala.
PRESSURE STABILIZED SOLAR COLLECTOR
Harry Harber 205-453-1746

The objective is to operate a 50-foot diameter Pressure Stabilized Solar Concentrating Collector, and confirm the feasibility of the concept, determine performance and efficiencies, establish system capabilities and potential as well as constraints. Subsequently, investigate and define potential commercial and industrial applications for the system, modify and refine the system design for adaptation to the commercial/industrial applications, and test and evaluate those system modifications and adaptations. MSFC will manage the project by accomplishing (1) testing to confirm the system concept as fabricated and installed; (2) further instrumenting, testing, and evaluating the system to determine performance, efficiencies, capabilities, and limitations of the system; (3) redesigning, refining system, modifying and incorporating adaptations to the system for commercial and industrial applications; and (4) testing, and evaluating the modified/adapted systems with the goal of recommending commercial/industrial applications.

Solar Energy Systems

W80-70317 **776-91-19**
Marshall Space Flight Center, Huntsville, Ala.
SMALL DISPERSED SOLAR SYSTEM APPLICATIONS
John M. Price 205-453-1288

The objectives are: (1) to develop preliminary solar system and specific site designs for certain remote locations in the United States and lesser developed countries, e.g., Central America, South America and the Caribbean; (2) to develop solar and wind energy project interface documents needed for management control; (3) to prepare project description document; and (4) to expand the pre-implementation phase activities to countries beyond the Latin Americas by repeating the present task activities as defined in the FY-79 RTOP. The approach will be to use the data, other materials, and in-country contacts now being developed, to generate the technical and managerial information requisite for preparation of procurement documents for the project implementation phase to follow. The method will be to use a time-phased continuation of the present study so as to maintain and amplify the knowledge and skills gained during the first phase.

Conservation and Fossil Energy

W80-70318 **778-45-12**
Lewis Research Center, Cleveland, Ohio.
COMBUSTION TECHNOLOGY
R. J. Priem 216-433-6225

The objectives of this work are to identify and verify NASA LeRC's aeronautical and space related combustion technologies for application to selected combustion needs of DOE and other organizations. These objectives will be attained through experimental studies to demonstrate technical feasibility of combustion concepts for energy projects, analysis of combustion designs for different applications, and design studies to determine the need, requirements, approach, etc. The work will include: (1) analyzing the tests results and preparing reports on the PFB combustion tests to understand the effects of combustion variables on the effluents from a PFB and how these variables indirectly influence turbine materials life; (2) complete combustor test cell; (3) perform tests to determine the potential advantages of using steam-assisted injection in premixed-prevaporized catalytic combustors for use in stationary gas turbine power plants; and (4) prepare reimbursable combustion technology plans as may be required.

W80-70319 **778-45-22**
Lewis Research Center, Cleveland, Ohio.
MATERIALS TECHNOLOGY
S. J. Grisaffe 216-433-4000

The objectives are to conclude efforts aimed at (1) Identifying those critical components of ground electric power conversion or ground propulsion systems that could benefit from the application or extension of aerospace materials technology; (2) Verifying, to some extent, the technical feasibility of using aerospace materials for such applications; and (3) Where promise is shown, using the information developed to formulate a detailed plan aimed at transferring the technology to the component or application of interest through a DOE reimbursable program. Research has been focused on turbine materials erosion/corrosion in a pressurized fluidized bed and on an automated plasma spray coating process. The research studies on turbine material erosion/corrosion for pressurized fluidized beds (PFB) burning coal will be concluded and reported for DOE use. The facility for automated plasma spray coating of utility turbine blades will be completed, demonstrated, and made available for contemplated DOE programs on verifying engine readiness of thermal barrier coatings.

W80-70320 **778-45-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ENERGY PLANNING SUPPORT AT JPL
G. E. Nichols, Jr. 213-577-9141

The objective is to support the initial problem definition and the subsequent preparation of approach papers, preliminary project plans, etc., for activities in the area of energy conversion systems.

W80-70321 **778-45-39**
Marshall Space Flight Center, Huntsville, Ala.
ENERGY TECHNOLOGY PLANNING SUPPORT AT MSFC
Ronald J. Harris 205-453-4162

The objective is to support the initial problem definition and the subsequent preparation of approach papers, preliminary project plans, etc., for activities in the area of energy technology planning.

W80-70322 **778-45-39**
Marshall Space Flight Center, Huntsville, Ala.
ENERGY TECHNOLOGY PLANNING SUPPORT AT MSFC
Ronald J. Harris 205-453-4162

The objective of this RTOP is to support the initial problem definition and the subsequent preparation of approach papers, preliminary project plans, etc., for activities in the area of energy technology planning.

Fossil Fuel Power Generation

W80-70323 **778-46-12**
Lewis Research Center, Cleveland, Ohio.
STATIONARY POWER RESEARCH AND TECHNOLOGY
F. J. Kutina, Jr. 216-433-4000

This effort will identify and evaluate national needs with respect to stationary power generation that can be solved by use or application of NASA's existing technology developed from aerospace programs in power and propulsion. Particular emphasis will be given to cogeneration applications. This will be accomplished through: (1) The improved analysis capability and the analytical screening of advanced concepts for potential application to stationary power with emphasis on cogeneration; (2) Evaluation of advanced components and technologies applicable to advanced systems in a real environment; (3) Preparation of energy R and D plans proposed for implementation by DOE on a reimbursable basis that are responsive to their projected needs.

W80-70324 **778-46-22**
Lewis Research Center, Cleveland, Ohio.
STIRLING ENGINE COMPONENTS AND SYSTEM CONCEPTS
Donald G. Beremand 216-433-4000

The objective of this activity is to identify and verify advanced Stirling engine technology and component and system concepts for ground power generation and propulsion systems applications relevant to R&D programs of DOE and other government organizations. These efforts are directed toward defining and developing an improved NASA posture in programmatic areas of new Stirling applications. The efforts shall specifically include: (1) the preparation of energy R&T plans, for implementation on a reimbursable basis by NASA, that are responsive to program objectives and needs of DOE and other organizations; (2) the improvement of Stirling engine analysis capability and the conduct of screening studies of advanced concepts for applications of interest to DOE and other organizations (such as cogeneration and total energy systems); and (3) the conduct of tests of advanced component and/or engine concepts.

W80-70325 **778-46-22**
Lewis Research Center, Cleveland, Ohio.
STIRLING ENGINE COMPONENTS AND SYSTEM CONCEPTS
Donald G. Beremand 216-433-4000

The broad objective of this activity is to establish the Lewis Research Center as a center of excellence in Stirling engine

technology by building a broad base of expertise relating to the efficient, low emission, Stirling engine and by applying this expertise to the development of reimbursable Stirling engine technology programs. The component technology, systems test and evaluation, and engine application efforts will relate to both propulsion and stationary Stirling applications. The Stirling engine technology base will be broadened through and contractual efforts that are complementary to established reimbursable programs. Early efforts will concentrate on acquiring a broad understanding in the areas of: (1) determining the engine requirements and identifying the potential of the Stirling engine for a broad range of engine applications; (2) acquiring experimental Stirling engine experience from a free piston 1 kW research engine with varied output load capability (including hydraulic output); (3) generating validated computer codes for predicting free-piston Stirling engine performance; (4) comparing alternate Stirling engines (free piston or kinematic, single or modular engines); and (5) investigating - experimentally - components and subsystem technology within critical areas.

W80-70326 **778-46-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VALIDATION OF STIRLING LABORATORY ENGINE
G. W. Meisenholder 213-577-9148

The overall technical objective is to provide the experimental and analytical data and end-use requirements necessary to establish a viable approach to the commercialization of a versatile Stirling Laboratory Research Engine (SLRE) which will: (1) be available to researchers in academic, industrial, and government laboratories as a laboratory research tool which can be used to study the Stirling cycle; (2) stimulate research relative to Stirling cycle machines with the goal of broadening the technology base within the United States; and (3) provide a tool for developing and evaluating improved components technology. The approach for FY-80 consists of the following: (1) continue performance tests of the preprototype SLRE; (2) complete conceptual design of prototype SLRE; (3) identify sponsor for continuation of project through the commercialization phase; and (4) write final report on preprototype SLRE.

Fossil Fuels

W80-70327 **778-47-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADVANCED COAL PROCESSING CONCEPTS
R. L. Phen 213-577-9145

The general objective is to identify and verify new coal processing technologies that reduce the costs of coal liquefaction and coal beneficiation while concurrently improving the environmental characteristics of the resultant fuels. There are three main elements composing this activity: (1) coal liquefaction technology, (2) coal beneficiation technology, and (3) related systems studies. A new coal liquefaction concept will be investigated with the objective of increasing oil yields from several processes now in pilot plant stage. The concept includes two stages, where the product from the first stage is mixed with a large amount of recycle coal minerals, and then reacted again at a higher temperature. Coal minerals are mild catalysts. In this secondary reactor asphaltenes and the heavy oil are further reduced to yield an essentially asphaltene-free medium oil. This product can now be either filtered or centrifuged to yield a solids-free medium oil and a high minerals content oil. The latter is used as the recycle oil. The coal liquefaction reactor constructed under FY-79 RTOP funds will be used in this investigation. The objective of the coal beneficiation research is to identify new avenues that include improvements in coal desulfurization. The approach will be the application of the coal differential reactor for investigations of oxidizing and reducing agents, leaching agents, and solvents under a variety of operating conditions of temperature, pressure, and chemical concentrations to promote the removal of total sulfur to meet new EPA sulfur compliance levels that call for up to 90% sulfur removal.

W80-70328 **778-47-29**
Marshall Space Flight Center, Huntsville, Ala.
COAL CONVERSION PROCESS & SYSTEMS
L. Whitt Brantley 205-453-3666

The general objective is to identify and evaluate the application of NASA's existing technology and capabilities to advanced energy technology implementation by the Tennessee Valley Authority (TVA) and the Department of Energy (DOE). Energy R and T plans will be developed and proposed for implementation by TVA and DOE on a reimbursable basis that are responsive to their projected needs. The main elements of this activity are the comparative assessment of candidate coal conversion processes and the establishment of utility (TVA) requirements and criteria for large scale coal conversion systems to be implemented in the 1985-90 time period. The requirements that will optimize the integration, operation and economics of the coal conversion system with several large industrial applications will be defined. The study will consist of activities to develop background information and requirements for the several applications. Technical/economic trade-off studies will be conducted to optimize coal conversion system characteristics for the applications.

Ground Transportation Systems

W80-70329 **778-48-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CONCEPTS FOR IMPROVED GROUND TRANSPORTATION SYSTEMS
Bradford C. Houser 213-577-9150

Based upon current DOT work and recent JPL in-house efforts, it is clear that an effective program in Transportation Flow Management could require a number of NASA technologies. These include: unified data system, robotics (artificial intelligence), sensor technology, communications, modelling and algorithm development, navigation, and guidance and control. This RTOP would address the question whether these various NASA technologies could contribute to a successful and useful Transportation Flow Management Program (TFM). The objectives are to: (1) identify government participants and their perceived role relative to TFM; (2) identify applicable NASA technology; (3) identify future sponsor(s) and define the approach for future reimbursable funding; and (4) develop an understanding of potential benefits by analyzing a few specific examples.

Industrial Energy Conservation

W80-70330 **778-49-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INDUSTRIAL CONSERVATION, COGENERATION, AND UTILIZATION OF ALTERNATIVE FUELS
Y. Nakamura 213-577-9247

With the implementation of new DOE energy regulations, increased attention will be directed at industrial conservation and utilization of alternative energy sources. The new energy measures will stimulate activities related to these areas. However, the situation is complex and enforcement will be a difficult task. The major emphasis of this study will be the development of a comprehensive specification of the factors that will affect the acceptances of industrial conservation measures, and the definition of possible NASA/JPL roles. Potential industrial conservation project concepts will be identified. The study effort will consist of three tasks. During FY-79, Task 1 specified the process, technical, fuel supply, industrial acceptance, and environmental factors associated with industrial conservation and culminated in the identification of target industries, potential sponsors, and programmatic areas that show promise of matching JPL's institutional interests. Tasks 2 and 3 are the logical extensions of the FY-79 effort and will be completed during FY-80. Task 2 evaluates the enforcement aspects of the new energy regulations. Task 3 assesses DOE/Industry R&D and analytic support needs

and develops project concept recommendations and recommended role for JPL.

Utility Systems

W80-70331 **778-50-15**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
UTILITY POWER SUPPLY AND LOAD MANAGEMENT
E. Framan 213-577-9265
(778-14-05)

The purpose of this study is to focus, coordinate, and develop NASA/JPL capabilities in systems design and management, communications and control, new power generation and storage technologies, and other expertise to permit their application to the increasingly severe problems of electric utilities systems. To meet this objective, a series of tasks will be identified and conducted in selected areas that will provide to NASA/JPL improved understanding of utility design and operations, and will delineate system and technical alternatives to utility problems and the associated value of such alternatives. Three tasks will be active in FY-80. The Distributed Energy Generation Systems (DEGS) task will continue the development of community centered utility system designs based on dispersed energy sources, technologies integrated with centralized energy supplies, and will expand the data base in this area. The Multi-Utility Supply Management task will identify concepts for information exchange within and among several operating utilities. The Load Management Requirements Analysis task will identify and develop system level requirements in the areas of communications, control, and information technology necessary to support the implementation of load management techniques in a specific operating utility. The DEGS task was initiated in FY-79; the other two are proposed to begin in FY-80. The results of this multiyear task will serve as a basis for development of a continuing activity under DOE sponsorship.

W80-70332 **778-50-29**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED ENERGY TECHNOLOGIES FOR UTILITIES
Rodney Bradford 205-453-0162

The general objective is to identify and evaluate the application of NASA's existing technology and capabilities to advanced energy technology implmentation by the Tennessee Valley Authority (TVA) and the Department of Energy (DOE). Energy R and T plans will be developed and proposed for implementation by TVA and DOE on a reimbursable basis that are responsive to their projected needs. The main elements of this activity in FY-80 are:(1) utility applications of multimegawatt coal gas fed fuel cells in the TVA region; (2) systems engineering analysis support of TVA's coal-based industrial energy complex feasibility and conceptual design studies; (3) feasibility analysis of underground storage in North Alabama and surrounding TVA service area of coal gas derived from an energy complex coal conversion system; and (4) requirements for application of magnetohydrodynamics (MHD) as an energy system in the TVA region. These proposed activities will include technical, economic, and programmatic analyses leading to project definition.

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS

Technology Utilization-Identification and Dissemination

W80-70333 **141-95-01**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AERODYNAMICS OF GROUND VEHICLES
T. R. Sisk 805-258-3311

The overall objective of this RTOP is to improve the efficiency and effectiveness of ground vehicles through (1) improved external aerodynamics efficiency, (2) improved ingestion efficiency for cooling and ventilation, and (3) definition of traffic interference effects for differing external geometry. Aerodynamic principles successfully applied to aircraft shapes will be employed using the coast-down techniques, hot-wire anemometry, wind tunnel testing and flow visualization methods for exploratory research on ground vehicles.

W80-70334 **141-95-03**
Marshall Space Flight Center, Huntsville, Ala.
TECHNOLOGY APPLICATIONS TEAM FOR MANUFACTURING PROCESSES (MATEAM)
J. H. Ehl 205-453-1520

The objectives are to (1) identify a wide variety of private-industry needs for solutions to manufacturing-process problems, (2) conceive and develop probable solutions based on NASA's developed/developing aerospace manufacturing-process technology, and (3) identify or create opportunities to demonstrate and transfer the probable solutions to private industry. The approach to this task is to conduct a program to provide manufacturing process technology to the industrial sector of the economy. A Manufacturing Process Applications Team (MATEAM) has been formed of appropriate technology experts. This team will define and rank problems for which solutions are achievable by NASA-driven technology, identify solutions, plan and schedule implementation, interface with users, identify probable markets and evaluate results. It includes NASA personnel appropriate for the task, industrial consultants as required, and other support personnel, working in conjunction with the Technology Utilization Office for liaison purposes. The MATEAM is contracted to IITRI, 10 West 35 Street, Chicago, Illinois 60616.

W80-70335 **141-95-15**
Lewis Research Center, Cleveland, Ohio.
NOISE REDUCTION PROJECT FOR POULTRY PROCESSING PLANTS
P. E. Foster 216-433-4000

The objective of this project is to utilize NASA LeRC experience in noise reduction to help quantify and characterize the noise environment in commercial poultry processing plants, define resource and regulatory constraints affecting noise reduction, and propose appropriate prototype engineering approaches to noise reduction. The proposed sound reduction measures may be implemented to determine their effectiveness in a typical poultry processing plant. Noise characteristics of work areas in two selected poultry processing plants were measured to establish a data base. The overall levels of sound, exact sound sources, mechanisms involved, and spectral energy characteristics were determined by measurement and analysis. A thorough review of applicable regulations and literature search of acceptable noise control methods will be completed. Using the information gained, techniques and/or devices for noise control will be developed and recommended.

Environmental Observations Applied Research and Data Analysis

W80-70336 **146-10-01**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE PROGRAM SUPPORT
E. A. Neil 301-344-6291
(146-50-03; 146-30-01)

The objective is to provide support to the Office of Space and Terrestrial Applications for the NASA Climate Program, and to coordinate GSFC climate activities with the NASA Climate Program Manager. Activities will consist of evaluations, recommendations, and developing plans and programs to fulfill NASA's mission in climate research. A second objective consists of development of a pilot, climate-data-base management system. Funding will be used in-house and through support services contractors to fulfill the objectives of the MPO as defined in its charter. Studies will focus on emerging technology and development of new technology. Conferences and workshops will be

arranged and supported to accomplish these studies. Additional funds for RTOP's requiring augmentation, and for other programmatic requirements to meet changing national or agency priorities, will be allocated and controlled through the RTOP. This will include management of a pilot data management system, which is a two year continuation of AN C-59, initially funded in 1978.

W80-70337 **146-10-03**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE RESEARCH
A. Arking 301-344-7208
(146-10-01; 146-10-02)

The objectives are to conduct a broad based research program in support of the NASA Climate Program, including (1) data base development, (2) special studies of climate processes, (3) climate modeling and analysis, and (4) climate observing system development. The effort to produce atlases of sea ice concentration and oceanic rainfall from Nimbus 5 ESMR data and plan and begin development of a radiation budget data set will be expanded. Guidelines for three special studies: (1) radiation and extended cloudiness; (2) hydrological processes related to soil moistures, evapotranspiration, and vegetation; and (3) cryospheric processes will be developed. Efforts involving boundary layer processes, solar climate coupling, soil moisture transport, cloud studies, and rainfall sampling statistics will continue. The GLAS GCM for climate research, coupled atmosphere-ocean models, SDM's with improved methods of parameterization of climate processes, and stochastic modelling techniques will be developed. Models in sensitivity, predictability, and diagnostic studies will be used. Satellite data to study sources and sinks of energy in the atmosphere will be analyzed. Efforts to develop concepts for a climate observing system with emphasis on precipitation will be expanded. Improved measurement techniques will be developed. Solar monitoring rocket flights will be continued.

W80-70338 **146-10-03**
Langley Research Center, Hampton, Va.
RADIATION BUDGET AND AEROSOL STUDIES
James L. Raper 804-827-3431
(146-10-04; 146-10-03)

The objectives are to (1) perform sensitivity studies using existing radiative transfer models to establish radiation budget measurement capabilities; (2) conduct investigations using existing satellite data to provide increased understanding of the Earth's radiation budget and limitations of current measurement capabilities; (3) conduct advanced mission studies consisting of flight simulations, development of sampling strategies, and system-sensor definition studies for missions beyond ERBE; (4) investigate sensor theoretical performance and methods for improving instrument accuracy and precision through use of advanced-design sources and calibration techniques; (5) develop a long duration, easily accessible, self-consistent radiation budget data set for the conduct of present and future investigations; (6) provide studies of measurement requirements and recommendations for the synthesis of the radiation budget-related portion of the climate program, and (7) conduct ground based measurements of atmospheric aerosols in support of satellite aerosol experiments using the LaRC 48-inch Lidar. Comments provided by NOAA on the ERBE development indicate areas of future required research and technology development. Studies will be conducted to define the required radiation budget measurement capabilities of the 'System-85' operational satellites (low-altitude and geosynchronous).

W80-70339 **146-10-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CLIMATE RESEARCH
R. C. Willson 213-354-3529

The primary objectives of this experiment are (1) the state-of-the-art, quantitative determination of the total solar optical irradiance outside the terrestrial atmosphere; (2) the monitoring of possible changes in these quantities over time scales ranging from less than a second during the spacelab 1 flight to many years, *using spacelab reflights of this instrument and other* observations presently planned and proposed; (3) the transfer of the flight observations to groundbased instrumentation through pre- and post-flight intercomparisons; (4) an in-flight comparison *with the active cavity radiometer on the solar maximum mission* near the end of its second year of operation to evaluate any changes in performance and extend its 0.1% measurement lifetime. Secondary objectives are to (1) assess and define NASA's program for special studies in air-sea interaction processes as an element of the NASA climate research program and (2) investigate use of satellite remote sensing techniques for measuring the fluxes of momentum, heat and mass across the air-sea interface through analysis of Seasat-1, Nimbus-7 and TIROS-N data over instrumented sites and in collaboration with such large scale experiments as JASIN, MARSEN and NORPAX.

W80-70340 **146-10-04**
Ames Research Center, Moffett Field, Calif.
AEROSOL CLIMATIC EFFECTS SPECIAL STUDY
J. B. Pollack 415-965-5530

A coordinated set of theoretical, laboratory, and field investigations of the chemistry and radiative properties of natural *(e.g. volcanic) and man-made atmospheric aerosol particles are* conducted in order to assess their impact on regional and global climate. The field investigations are intended to provide complementary information on aerosols to that being obtained from spacecraft platforms (e.g. SAM 2 and SAGE) so as to insure that a comprehensive set of aerosol properties are gathered for climate analyses. The theoretical and laboratory tasks are directed at interpreting and utilizing the aerosol data sets to perform the desired climate assessments. The centerpiece of the field investigations is a set of coordinated aerosol measurements, which are flown together on an appropriate aircraft platform (e.g. U-2). When possible, these flights are conducted in conjunction with spacecraft and other airborne aerosol measurements. Information is obtained on both the aerosol formation mechanisms and on their radiative properties so as to enable the development of a predictive capability as well as a determination of the present climatic effects of aerosols. Both theoretical modeling and laboratory studies are used to further define the mechanisms of aerosol formation, to provide hypotheses that can be tested by the field investigations, and to provide ultimately the predictive tools. Theoretical investigations involving radiative transfer, dynamics, and aerosol formation are utilized for making the climatic assessments.

W80-70341 **146-20-01**
Langley Research Center, Hampton, Va.
COORDINATION, ADVANCED STUDIES, AND PLANNING IN SUPPORT OF THE ENVIRONMENTAL QUALITY PROGRAM
J. P. Mugler, Jr. 804-827-2717

The purpose of this RTOP is to provide program coordination, assessment, and advanced planning support to OSTA in the environmental quality program. Specifically, this role requires the day-to-day assessment and evaluation of the agency's EQ programs; conducting long range studies and developing future program options in environmental quality; defining user needs and developing cooperative programs with user agencies; preparing and documenting rationale for environmental problems on which the program focuses; and drafting congressional, OMB, and RTOP call material for the agency's EQ programs. In order for Langley to continue its support of the OSTA environmental quality program, it must maintain an up-to-date assessment of agency EQ programs and be keenly aware of both agency and user needs in environmental quality. This will be accomplished through the day-to-day involvement of the center with NASA Headquarters management and user organizations by actively participating in the initial planning and working group meetings involving both NASA SR&T and cooperative programs. Langley will assist NASA Headquarters in assessing current SR&T activities, planning for future monitoring programs, and developing and implementing user programs in areas where maximum utilization of NASA technology can be realized.

W80-70342 **146-20-08**
Goddard Space Flight Center, Greenbelt, Md.
APPLICATION OF REMOTE MEASUREMENT TECHNIQUES TO TROPOSPHERIC POLLUTION MONITORING
Richard W. Stewart 301-344-8895
(146-20-10; 146-20-09)

The objectives are to (1) develop an understanding of tropospheric environmental problems that may be amenable to solution through the use of remotely sensed data, (2) develop, evaluate, and demonstrate remote sensing concepts for observing the nature and distribution of tropospheric pollution, and (3) demonstrate the application of remote sensing technology to the specific problem of assessing the impact of urbanization and industrialization on global, regional, and urban air quality. These objectives will be met through a coordinated program of theoretical modeling, observations and data analysis. The modeling will investigate the relationships between observed tropospheric chemical structure and the chemical, physical, and biological processes which determine that structure. Observation and data analyses will evaluate the capabilities and limitations of NASA remote sensors for detecting and monitoring polluted air masses.

W80-70343 **146-20-08**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
APPLICATION OF REMOTE MEASUREMENT TECHNIQUES TO TROPOSPHERIC POLLUTION MONITORING
R. T. Menzies 213-354-3787

The laser absorption spectrometer (LAS) is an active, nadir-looking instrument which uses infrared CO2 lasers and heterodyne receivers, to measure vertical burdens and profiles of tropospheric species via differential absorption of the laser radiation at selected wavelengths. The LAS has been successfully flown in the JPL twin-engine Beechcraft and on the NASA Ames Research Center CV-990, to measure tropospheric ozone distributions. Recently it was flown in the Virginia coastal area, in collaboration with two other aircraft which were instrumental with in situ trace species sensors, to study the buildup of ozone in urban plumes. Further aircraft flights are being planned to measure selected atmospheric constituents. The LAS has the ability to cover large areas under day or night conditions. There are two main objectives for FY-80: (1) to conduct flights aimed toward achieving a greater understanding of the ultimate sensitivity of the LAS technique and assess the various contributions to uncertainties, such as the albedo fluctuations from varied terrain, the response times of the instrument electronics, the influence of the water vapor continuum absorption, and receiver noise; and (2) to gain experience in automated spectral tuning of the laser transmitter wavelengths in order to achieve the ability to measure several species in a short amount of time. The results will aid in the design of an LAS instrument for use on space shuttle missions.

W80-70344 **146-20-10**
Langley Research Center, Hampton, Va.
APPLICATION OF REMOTE MEASUREMENT TECHNIQUES TO TROPOSPHERIC POLLUTION MONITORING
Frank Allario 804-827-2576
(146-20-01)

The objective of the RTOP is to develop a basic understanding of those environmental problems associated with the global troposphere through a coordinated program of atmospheric modeling and measurements from satellite, aircraft and ground-based platforms. Remote sensing concepts for observing the nature and distribution of tropospheric pollution will be developed, evaluated and demonstrated, and the application of remote sensing technology to the specific problem of assessing the impact of urbanization and industrialization on global, regional and urban air quality will be demonstrated. The approach for achieving the objectives will consist of several elements: (1) to continue development of the global tropospheric photochemical model, and to couple it to a geochemical flux model; (2) to continue development of passive remote sensor technology for satellite investigations, and to perform measurements of the seasonal and temporal variability of atmospheric ammonia; and (3) to accelerate development of DIAL technology for implementation in coordinated aircraft measurements of the global troposphere, and for demonstration in field measurement programs of user agencies.

W80-70345 **146-20-23**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF THE UPPER TROPOSPHERIC AEROSOL LAYER AND OF THE SAHARA DUST
O. B. Toon 415-965-5971
(146-10-04)

Sulfate production in the upper troposphere may be a globally distributed source of condensation nuclei. These nuclei are essential in cloud formation. A one-dimensional model of the chemistry and physics of sulfate aerosol production will be used to estimate the formation rate of upper tropospheric condensation nuclei. This RTOP will relate the model calculations to observations and estimate the significance of anthropogenic perturbations. Each year dust from Saharan dust storms spreads across the tropical Atlantic in an optically thick layer easily visible from satellites. A three-dimensional boundary layer model, containing aerosol microphysical and cloud removal processes to simulate the dust, will be constructed. The model output will be used to relate aerosol optical properties to satellite observations. The model will also be used to develop parameterizations for more sophisticated models. We will extend our Sahara model to more complex sulfate pollution problems as the physics and chemistry in the model improves.

W80-70346 **146-30-02**
Marshall Space Flight Center, Huntsville, Ala.
GLOBAL WEATHER RESEARCH
W. W. Vaughan 205-453-3100

The objectives are to contribute to the NASA Global Weather Research Program objectives by performing geophysical fluid dynamics experiments, theoretical activities to develop new and improved spaceborne sensing techniques, theoretical and laboratory models, and improved understanding of atmospheric behavior by contributions to the development of more realistic general circulation models. The approaches are to continue theoretical studies of potential spacelab atmospheric general circulation experiments (AGCE), simulate the Earth's large-scale baroclinic atmospheric circulation, examine global weather processes in the context of turbulence modeling, to gain improved understanding between various scales of motion, and to continue to utilize satellite data to understand global weather processes.

W80-70347 **146-30-02**
Goddard Space Flight Center, Greenbelt, Md.
GLOBAL WEATHER RESEARCH
M. Tepper 301-344-7624

The objectives are: (1) to develop new and improved spaceborne remote sensing systems which will provide the observations required to attack important problems in the behavior of the atmosphere; and (2) to exploit the capabilities of remote sensing in achieving a better understanding of processes which influence the state and behavior of the atmosphere and in large-scale numerical weather forecasting. Theory, numerical models, laboratory measurements and field experiments will be used to define, develop and evaluate new and/or improved remote sensing techniques to observe such parameters as profiles of atmosphere temperature, moisture and pressure, precipitation, surface properties and atmospheric radiative properties. Infrared/microwave techniques for meteorological parameter retrieval, and analysis and assimilation of satellite data into numerical forecast models will be studied and their impact assessed. New and improved parameterization approaches, sounding techniques, and analytical filtering techniques aimed at improving forecast models will be studied.

W80-70348 **146-30-02**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
GLOBAL WEATHER RESEARCH - MICROWAVE PRESSURE SOUNDER (MPS)
D. A. Flower 213-354-4151

The objectives of this task are as follows: (1) microwave pressure sounder - verify with an aircraft borne instrument the concept of a millimeter wave technique for remotely measuring

atmospheric pressure at the Earth's surface. Surface pressure is an important meteorological parameter but unlike other parameters no method at present exists for its remote measurement. Aircraft experiments to verify the concept will provide the necessary confidence to proceed to a system demonstration with a satellite instrument. (2)monitoring of winds from satellite - evaluate techniques which might be used onboard an orbiting spacecraft to provide useful measurements of atmospheric winds on a global basis. (3) data analysis from cloudy atmospheres - studies will be conducted to improve numerical weather forecasting. The development of data analysis methods will be carried out at JPL, and application of the resulting retrieval techniques to large scale analysis of satellite data will be carried out at GSFC in collaboration with Drs. J. Susskind and M. Balem.

W80-70349 **146-30-03**
Langley Research Center, Hampton, Va.
DEVELOPMENT AND APPLICATION OF AN AIRBORNE WATER VAPOR DIAL SYSTEM
E. V. Browell 804-827-2576
(146-20-10)

An Airborne Water Vapor DIAL System will be completed and its capabilities will be evaluated by making water vapor profile measurements in the boundary layer, troposphere, and tropopause regions of the atmosphere. These data will be analyzed to improve the understanding of atmospheric inhomogenieties and transport processes. Three-dimensional water vapor profile information will also be studied to determine the usefulness of these data in weather forecasting. When assembly of the aircraft DIAL system is completed, it will be optimized for near-IR measurements of water vapor. The French wavelength control device will be added, and the system will be ground tested prior to its initial flight. The system will be locally flight tested prior to its evaluation in various science investigations. Tropospheric and tropopause investigations will then be conducted following a science plan to be established early in FY 1980.

W80-70350 **146-30-04**
Wallops Station, Wallops Island, Va.
SOUNDING ROCKETS
T. W. Perry, Jr. 804-824-3411

The objective is to provide temperature and wind profile data from WFC in cooperation with some 25 other non-NASA sites (U.S. and foreign) to provide synoptic and unique correlative data for Nimbus-7, SAGE and several operational NOAA satellites. In addition to providing the required data, the above cooperative effort (1 launch from WFC per week) preserves a valuable and cost effective operational reciprocity arrangement with all of the DOD sites and provides an international operational foundation for near world wide operational options to provide correlative atmospheric dynamic and constituent data support for NASA and other satellite investigations. Weekly temperature profiles from 70 to 20 km are obtained by WFC, combined with other network soundings and provided to NOAA for Upper Air Chart analysis. These analyses are used by Nimbus-7, SAGE and other satellite investigators. WFC serves as the data focal point for the network data supplied to most users and has assumed a quality control role for the data to insure that the highest quality data possible is being supplied the satellite users. A continuing effort is underway to evaluate current rocket system performance and capability against satellite and synoptic measurement requirements for precision and accuracy and to identify future correlative support requirements for newly conceived and approved satellite systems.

W80-70351 **146-40-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
OCEANIC PROCESSES PROGRAM SUPPORT
P. J. Rygh 213-354-7240

The objective is to provide the oceanic process program at NASA Headquarters with technical and administrative support in FY 80. Numerous technical questions arise during the normal operations of any program office; this is especially so in the oceanic processes area, where several different remote sensor techniques are proposed or are under development, where both operational and R&D flight missions are under consideration, where spacelab applications may become of great importance, and where an extremely diverse user community wishes to remain interactive in major mission planning and information system product definitions.

W80-70352 **146-40-02**
Goddard Space Flight Center, Greenbelt, Md.
MESOSCALE ICE DYNAMICS PROCESSES
H. Jay Zwally 301-344-8239
(146-10-03)

The objectives are to: (1) coordinate ice dynamics and cryospheric processes research and development; (2) develop methods for extraction of ice parameters from multifrequency/passive microwave and other space data; (3) develop relationships between observed ice parameters and quantities that describe ice/ocean/atmosphere processes and ice dynamics; (4) conduct research demonstrating use of derived ice quantities in ice models, glaciological research, process studies, weather/climate models, and commercial/operational ice maps. Interaction with the scientific, operational, and commercial communities will continue to identify ice requirements that can be met by satellite sensing. Improved techniques for extracting ice parameters from remote sensing data and improved methods for evaluating, formatting, and distributing ice information to the research and user community will be developed. Principal efforts will include radiative transfer modeling, data inversions, multifrequency and multisensor algorithm developments, analysis of accuracies, ice modeling, ice processes research, and analysis of the usefulness of the satellite-derived information. RTOP supports ocean processes and climate programs and end objectives of understanding and managing the environment.

W80-70353 **146-40-03**
Goddard Space Flight Center, Greenbelt, Md.
MESOSCALE OCEAN SURFACE LAYER PROCESSES AND MODELING
J. L. Mueller 301-344-7895

The objectives are to: (1) improve methods for estimating bulk ocean surface layer properties from radiometry; (2) investigate mesoscale dynamics using models with remote and in situ observations; and (3) improve atmospheric corrections for ocean radiometry. Data from aircraft, Nimbus-7 CZCS and research vessels will be analyzed to construct combined remote plus in situ descriptions of mesoscale ocean phenomena. Modeling of ocean fronts and shelf density structure formation will continue and be extended to include biological and sediment transports in order to relate ocean color patterns to dynamics. New work will be proposed to improve atmospheric corrections to ocean color data. This RTOP supports the following major programs; ocean dynamics, and water quality. These in turn support the following end objectives: (1) food resources, (2) environment, and (3) coastal development.

W80-70354 **146-40-04**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MESOSCALE EXPERIMENTAL ANALYSIS - OCEAN DYNAMICS
O. H. Shemdin 213-354-2447

The objective is to gain insight and to interpret such remote sensing data as pertains to the measurement of wind, waves, currents, sea-surface temperature and detection of oceanic fronts and ice edge processes through collaborative data analysis collected in controlled experiments incorporating adequate surface truth. More specifically the objectives are to: (1) investigate SAR imaging mechanisms in detecting oceanic fronts and ice edge processes, (2) define short wave modulation under actions of wind and long waves to relate to EM-interactions with short waves, (3) utilize the SAR for studies of wave transformation in shallow water, (4) investigate scattering of EM-waves from the ocean surface utilizing tower scatterometers under various wind, wave and slick (both artificial and natural) conditions and simultaneously with careful surface truth, (5) measure capillary waves and surface wind stress modulation with a wave follower, and (6) specify the SAR system transfer function. The approach is to (1) analyze the data acquired in Marsen, (2) coordinate the collaborative investigations related to the above objectives

among the NASA investigators and those affiliated with academic and government organizations in the U.S. and in Europe, (3) support the U.S. scientists in MARSEN through collection and dissemination of a complete data file, and (4) finally, prepare the results of investigations for publication in referred journals.

W80-70355 **146-40-05**
Wallops Station, Wallops Island, Va.
MICROSCALE OCEAN SURFACE DYNAMICS
N. E. Huang 804-824-3411
(146-40-13)

The motions in the oceans are driven primarily by the flux of momentum, moisture, and heat through the air-sea interface. These microscale couplings between the atmosphere and the ocean directly influence the appearance and condition of the sea surface which are readily detected by microwave radars. Therefore, the study of the interaction between electromagnetic wave and microscale ocean parameters will provide not only the foundation for understanding basic ocean dynamics processes but also for proper interpretation of remote sensing data. The specific objectives of this project are: (1) to understand the dynamic processes of the ocean that are responsible for changes in the microstructure of the ocean's surface; (2) to study the interactions between the surface microstructure and electromagnetic waves from given remote sensors; (3) to establish techniques for the retrieval of the ocean's dynamic characteristics from given electromagnetic signals from remote sensors, and (4) to use the remotely sensed data as inputs in ocean dynamics models.

W80-70356 **146-40-05**
Langley Research Center, Hampton, Va.
MICROSCALE OCEAN SURFACE DYNAMICS
W. L. Jones 804-827-3631

The technical objectives of this RTOP are to provide a physically unambiguous basis for the interpretation and quantitative utilization of remote active microwave observations of oceanic conditions, to assess the impact of the same on relevant problems in oceanography, and to publish results in referred literature. For FY-79, the emphasis was on four major areas, namely; wind-wave interactions, wave-wave interactions, direction wave energy distribution, and radar backscatter modeling. During FY-80 aircraft and/or tower scatterometer data obtained during GOASEX, JASIN and MARSEN oceanographic experiments will be analyzed and reported. Further a joint NASA/NOAA research program will be established to investigate microwave scatterometer measurements in hurricanes.

W80-70357 **146-40-07**
Wallops Station, Wallops Island, Va.
OCEAN CIRCULATION AND TOPOGRAPHY
C. D. Leitao 804-824-3411
(146-40-05)

The objectives are to process three and one-half years of GEOS-3 altimeter-derived surface topography data to (1) determine the intensity and both spatial and temporal variations of the geostrophic currents in the northwestern atlantic ocean and (2) separate the geostrophic kinetic energy into mean boundary currents and mesoscale eddies. In addition, altimeter waveform data will be processed to calculate the surface drift current. GEOS-3 high intensity altimeter data covering the period from July 1975 to December 1978 and acquired in the area between 20 deg. to 42 N and 60 deg to 82 W will be processed to produce both long term (3-1/2 years) and short term (1 month) average topographic maps. Differences between the long and short term averages will provide information on the variability of the geostrophic energy field. Additionally, the altimeter waveform data acquired in the high intensity, high data rate mode will be processed to estimate significant wave height and surface wave skewness. These parameters will be used to produce surface drift current maps as discussed by Huang (1079).

W80-70358 **146-40-07**
Goddard Space Flight Center, Greenbelt, Md.
OCEAN CIRCULATION AND TOPOGRAPHY
J. G. Marsh 301-344-5324

The objective is to provide a physically unambiguous basis for the interpretation and quantitative utilization of remote sensing observations of sea surface topography and to assess the impact of this on relevant problems in oceanography; to develop analytical and interpretative techniques for determining the contributions of the ocean geoid, tides, baratropic effects and dynamic topography due to general and meso-scale ocean circulation phenomena to satellite radar altimeter measurements of sea surface geometry; and to conduct simulation analyses as well as real data analyses to identify and formulate ways of achieving improvements in the computation of satellite orbits so that orbital accuracies of 20 cm or better with respect to the center of mass of the earth can be achieved. Satellite altimetry will be analyzed to develop maps of the global shape of the oceans. Departures of this topographic surface from the geoid, or deviations of monthly surfaces from the long-term mean, yield information on dynamic ocean processes.

W80-70359 **146-40-07**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
USE OF SATELLITE AND CONVENTIONAL DATA FOR THE STUDY OF TROPICAL PACIFIC CURRENTS
G. H. Born 213-354-4644

The objective of this research, a continuation of the corrobative activities between JPL and Scripps started under AN No. 258 (OP-42), is to correlate variations in the current systems of the tropical North Pacific Ocean employing satellite altimetry data from SEASAT and GEOS 3. Both JPL and Scripps funding requirements for FY-80 are included in this RTOP.

W80-70360 **146-40-08**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE RESEARCH (CRYOSPHERE) MISSION ICE & CLIMATE EXPERIMENT (ICEX)
S. Willis 301-344-8239

The objective is to conduct the definition phase studies for the ice and climate experiment (ICEX) in preparation for an FY-81 new start initiative. The four major areas requiring definition are: (1) overall mission implementation; (2) instrument development, both hardware and algorithms; (3) spacecraft; and (4) ground processing and data dissemination.

W80-70361 **146-40-10**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SCRIPPS DOWNLINK STATION TECHNICAL SUPPORT
N. A. Renzetti 213-354-4471

This RTOP will continue the joint venture between NASA-JPL and the Scripps Institution of Oceanography (SIO) by providing engineering and communications support to SIO for their oceanographic research. JPL will provide engineering and communications support to SIO for their continued use of data from spacecraft such as Tiros N and Nimbus 7 in the following areas: (1) sustaining engineering support to the remote sensing terminal implemented at SIO during FY-79 with funding from NASA, the Office of Naval Research, and the National Science Foundation, (This support is to cover the engineering to solve problems that arise during the operation of this facility and will assist with the minor mods necessary to keep the terminal in proper configuration to meet the changing conditions of the missions and spacecraft performance); (2) serve as point of contact with the NASA Communications Division at the Goddard Space Flight Center and with its project operations centers in providing data to the SIO investigators on a global basis. (This is a cost effective mode of operation); and (3) establish and maintain TTY, voice, and data communication capabilities necessary to transfer NASA-acquired data from spacecraft for transmission to SIO.

W80-70362 **146-40-13**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED OCEAN SENSOR SYSTEMS DEVELOPMENT
Hongsuk H. Kim 301-344-6465
(666-32-21)

The objective is to develop advanced ocean colorimeter and short pulse microwave radar sensor systems for monitoring the ocean surface from space. Specifically: (1) to provide a physically unambiguous scientific basis for interpretation and utilization of

ocean colorimeter data for remote sensing of the ocean biosphere and general oceanology; and (2) to provide an unambiguous scientific basis for the measurement of ocean wave parameters using short pulse microwave radar techniques. Studies will be continued for improving computation of ocean upwelling radiance by means of model ocean-atmosphere settings and data from U-2 aircraft and spacecraft missions. Aircraft experiments will also be continued using the Goddard short pulse radar and supporting modeling of short pulse scatter from rough surfaces. This RTOP supports the following NASA programs: (1) ocean processes; (2) space shuttle ocean color experiment (STS-2-OCE); (3) NOSS; and (4) ICESAT.

W80-70363 **146-40-13**
Langley Research Center, Hampton, Va.
ADVANCED OCEAN SENSOR SYSTEMS DEVELOPMENT
C. T. Swift 804-827-3631

The objective of this work is to provide a physically unambiguous and accurate basis for the interpretation and quantative utilization of remote passive microwave observations of the open ocean and the coastal zone, including the Great Lakes, and to publish the results in the referenced literature. The prime geophysical parameters of interest are salinity and temperature in the ocean, and ice thickness and melting in the Great Lakes. The approach is to install the reconfigured Langley precision radiometer systems onboard the NASA Wallops and Johnson aircraft to collect data, in conjunction with high quality ground truth, to assess the overall accuracy of the radiometrically derived geophysical parameters. Concurrent with this activity, a new UHF radiometer and antenna will be developed in order to expand the capability of the existing passive microwave remote sensors at Langley. For example, the UHF system will provide much more accurate measurements of salinity as the ocean water temperature becomes cold. The work will also include the developement of retrieval algorithms, analysis of data, and the preparation of a preliminary description of a design for a future satellite ocean salinity and temperature remote sensing system.

W80-70364 **146-40-13**
Wallops Station, Wallops Island, Va.
ADVANCED OCEAN SENSOR SYSTEMS DEVELOPMENT
J. T. McGoogan 804-824-3411
(146-40-05)

The objectives are to provide a physically unambiguous basis for the interpretation and quantitative utilization of remote active microwave observations of oceanic conditions to assess the impact on relevant problems in oceanography, and to publish the results. Radar satellite altimetry techniques will be evaluated to allow options for the best choices for hardware development in FY-81. Capabilities and limitations of altimetry techniques will be investigated for obtaining information on directional wave spectra. Multi-beam or scanning radar altimetry techniques will also be investigated as a means of achieving better than one-meter accuracies in the determination of sea surface topography deviations from the geoid. Open ocean, requirements beyond SEASAT-A will be investigated to determine which sensor concepts offer the most promise. These concepts will be modelled (RTOP 146-40-05) and field tested using the airborne AAFE altimeter, and surface contouring radar as appropriate. Based on these studies, recommendations for future instrument development will be made.

W80-70365 **146-40-14**
Langley Research Center, Hampton, Va.
ENVIRONMENTAL BASELINE MONITORING--COASTAL AND MARINE PROCESSES
E. Brian Pritchard 804-827-3645

The goal of this research is to increase the understanding of and the relevance of remote sensing to coastal and marine processes with emphasis on bioprocesses. Analytical, laboratory, and field investigations will be used to (1) determine the in-water optical properties of turbid waters and their relationship to the remotely sensed signal (eight in-water and three out-of-waters optical parameters, and the physical-chemical properties of the waters will be measured); (2) extend the capability of the active (Lidar) technique for phytoplankton density and diversity measurement to more diverse environmental conditions than currently possible through lab/field correlation experiments; (3) apply active and passive remote sensors to the study of large-scale ocean productivity in the northeast Atlantic coastal zone (including the influence of warm core wings); (4) demonstrate the potential for pollution monitoring with a passive, multifrequency microwave system through lab measurements of the dielectric constants of various pollutant-water mixtures; and (5) complete analysis and publication of research aimed at oil spill and ocean pump detection and quantification.

W80-70366 **146-40-15**
Wallops Station, Wallops Island, Va.
DEVELOPMENT OF IMPROVED ALTIMETER PRECISION FOR FUTURE SATELLITE MISSIONS
J. T. McGoogan 804-824-3411
(146-40-05; 146-40-13)

The objectives are to develop the techniques and critical hardware subsystems required to increase the precision of satellite altimeters, and to assess the total performance that can be achieved with a variety of system options so that the proper options can be matched to future mission requirements.

W80-70367 **146-40-16**
John F. Kennedy Space Center, Cocoa Beach, Fla.
NON-POINT SOURCE MONITORING
Roy A. Bland 305-867-3017

The purpose of this RTOP is to continue the study now underway into using remote sensing and data processing techniques for improving input parameters for EPA water quality models. The specific objectives proposed for the coming year involve a change in emphasis to the applicability of a digital data base for the Hydrologic Simulation Program FORTRAN (HSPF) model to improve its effectiveness and make it more economical to use in new drainage basins. This data base will use satellite data, such as Landsat and GOES, in the computation of the many complex parameters required by HSPF. This project will supplement the work presently underway by EPA in the development and testing of the HSPE model. Much of the model development, testing, ground truth, etc., work sponsored by EPA will be directly applicable to this project, greatly facilitating the integration of remote sensing and data technology at minimum cost.

W80-70368 **146-40-17**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING OF AIR-SEA INTERACTION PHENOMENA
F. C. Jackson 301-344-5380
(146-40-13)

The objectives are to: (1) demonstrate advanced microwave radar techniques for measurement of ocean wind and wave parameters; (2) to refine the scanning multichannel microwave Radiometer (SMMR) ocean algorithm to improve geophysical parameter retrieval accuracy and mitigate interference from rain; and (3) to demonstrate applications of SMMR data to large-scale air-sea interaction problems.

W80-70369 **146-40-18**
Goddard Space Flight Center, Greenbelt, Md.
INVESTIGATION OF CATASTROPHIC PHYTOPLANKTON EVENTS
James L. Mueller 301-344-7895

The objective is to develop and validate techniques for using the Nimbus-7 coastal zone color scanner (CZCS) monitoring red tide blooms off the west coast of Florida, and as part of this problem, to track the Loop Current in the eastern Gulf of Mexico.

W80-70370 **146-40-19**
Goddard Space Flight Center, Greenbelt, Md.
RESEARCH APPLICATIONS OF OCEAN DATA IN LARGE-SCALE FORECASTING MODELS
M. Halem 301-344-7482

The objective is to provide theoretical support for the application of satellite observations of ocean-atmosphere interactions. The principal applications are: (1) the assimilation

of surface wind and temperature data into numerical weather prediction (NWP) models, and the determination of their impact on short-term forecasts; (2) the prediction of upper ocean currents, temperatures, sea state, mixed-layer depths and upwelling zones; and (3) the interactions of the atmospheric and oceanic circulation systems on time scales of a month or more. This program specifically includes ocean modeling and is designed to support extended-range forecasting and climate studies which depend on ocean-air interactions.

W80-70371 **146-40-20**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PHASE A OCEAN RESEARCH MISSION STUDY
R. Neilson 213-354-3324

This document proposes a phase A study of an ocean research mission as a candidate for an FY-82 new start. The focus of the study will be the definition of an observation system for measurement and monitoring of the global ocean circulation through the use of earth orbital systems. Emphasis will be placed upon: development and justification of measurement requirements through close interaction with a science working group; inventory and critical assessment of remote measurement techniques available; inventory and critical assessment of other complementary measurements available or projected during the time period; and development of observation system options. After the midterm period of the study, the most attractive of the system options will be selected for further definition. Engineering tradeoffs will be performed for the selected options in order to generate a cost envelope for the mission.

W80-70372 **146-40-21**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NASA AIRBORNE IMAGING RADAR FACILITY
E. R. Caro 213-354-3096
(667-36-05; 677-41-04; 146-40-04)

The airborne imaging radar facility operated for NASA by JPL has been instrumental in the progressive growth of synthetic aperture radar technology in recent years. Using the NASA/Ames Research Center CV990 as a test bed, a remote sensing capability has been made available to environmental programs investigators and scientists performing studies and collecting data in the fields of meteorology, oceanography, polar ice mapping and pollution monitoring. The work proposed here will provide a logical time phased program to enhance the reliability and expand the capabilities of a proven cost effective test facility.

W80-70373 **146-40-22**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EPA/JPL LAKE CLASSIFICATION RESEARCH, DEMONSTRATION, AND TRANSFER PROJECT
Richard H. Green 213-354-5677

The overall project objective is to demonstrate and transfer to the U.S. Environmental Protection Agency (EPA), the technology and capability to utilize remote sensing data to augment and enhance the EPA water quality monitoring program. Specifically, the project will: (1) develop and further refine techniques and procedures for using Landsat and aircraft multispectral scanner data to characterize eutrophication in inland lakes; (2) develop methods for utilizing existing water quality environmental data bases in conjunction with remote sensing to extend the useful life time of the data base as well as to augment its capability; (3) develop procedures for incorporating data about land use practices and the diurnal and seasonal variations in water quality; and (4) transfer this technology to the EPA for operational use so as to assist in the development, maintenance and updating of the water quality data base relative to lake classification and trophic indices.

W80-70374 **146-40-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CRYOSPHERE RESEARCH
C. Elachi 213-354-5673

The objective is to develop the algorithms for the measurement of polar ice motion using a spaceborne imaging radar (SAR) and to determine the relationship between the system parameters (i.e. orbital accuracy, sensor characteristics,...) and the accuracy of the resulting geophysical data. The approach is to use A/C and SEASAT-A SAR data to test the algorithms which are derived from theoretical analysis. The algorithms will be first checked for land targets using sequential SEASAT-A SAR images of polar ice.

W80-70375 **146-50-02**
Marshall Space Flight Center, Huntsville, Ala.
SEVERE STORMS AND LOCAL WEATHER RESEARCH
W. W. Vaughan 205-453-3100

This activity will contribute to the NASA Severe Storms and Local Weather Research Program by conducting applied research and development using space related techniques and observations that will increase the basic understanding of storms and local weather to improve the accuracy and timeliness of local weather forecasts and severe weather warnings. Utilizing the talents of university and private contractor groups, plus the MSFC in house talents and laboratory capabilities, specific research activities as described in the tasks of this RTOP will be accomplished. These tasks are: (1) cloud microphysical processes (CMP), (2) CMP theoretical/experimental activities, (3) AVE-SESAME 79 data sets, (4) applied research AVE-SESAME, (5) mesoscale storm field experiment, (6) mesoscale model evaluation, (7) doppler lidar/wind measurements, (8) severe storm ionosphere coupling, (9) lightning survey experiment, (10) scientific & programmatic support, (11) lightning mapper sensor dev., (12) R&D techniques for lightning det., (13) atmospheric electricity & related research, and (14) applied research.

W80-70376 **146-50-02**
Goddard Space Flight Center, Greenbelt, Md.
SEVERE STORMS AND LOCAL WEATHER RESEARCH
W. E. Shenk 301-344-5948
(146-50-02)

The objectives of this activity are: (1) develop improved objective methods to detect and predict severe storms and mesoscale phenomena; (2) obtain a better understanding of storm dynamics; and (3) specify new satellite capabilities for detection and understanding of these phenomena. The approach will involve synthesizing measurements of severe storms and mesoscale phenomena and their environments and study these data using numerical and statistical models wherever possible. Some of the measurements will have been obtained from satellite, aircraft, and conventional sources in conjunction with SESAME 79, a major severe local storm field program. Special processing systems will be used to extract parameters to be used in models. New aircraft sensors will be developed and tested to provide new or improved data. The results of various research approaches will be synthesized for a systems approach to the problem of severe storm detection and prediction.

W80-70377 **146-50-05**
John F. Kennedy Space Center, Cocoa Beach, Fla.
SATELLITE FREEZE FORECAST SYSTEM DEMONSTRATION PROJECT
Frank W. Horn, Jr. 305-867-3017
(146-50-02)

The objective of this effort is to continue work in support of the satellite freeze forecast system demonstration project with NOAA. The effort will include continued work in developing statistical coefficients for the freeze model, incorporating the digital satellite data base, automating key stations data gathering and reporting, and continued evaluation of the satellite freeze forecast system performance. GSFC tapes of GOES satellite data and current NWS data will provide the data base for digital coefficient development. Microprocessors are to be engineered and installed at the key stations to automatically record and report physical data for the freeze model. In assessing the system performance, predictive products will be compared to actual satellite data and other measured ground data.

W80-70378 **146-60-01**
Goddard Space Flight Center, Greenbelt, Md.
OZONE DATA REDUCTION AND ANALYSIS AND SOLAR UV VARIABILITY
Donald F. Heath 301-344-6421
(145-20-02; 146-20-16)

The objectives are: (1) investigation of geophysical processes related to variability of atmospheric ozone; (2) use stratospheric ozone data for validation of photochemical models; (3) provide ozone profile data in support of satellite measurements; (4) investigation of solar variability; and (5) adapt LIDAR system for OH/03 measurements from aircraft.

W80-70379 **146-60-01**
Wallops Station, Wallops Island, Va.
SOUNDING ROCKET AND BALLOON MEASUREMENTS FOR DATA BASE DEVELOPMENT
T. W. Perry, Jr. 804-824-3411

This RTOP will provide sounding rocket, balloon and ground measurement support for the environmental quality and upper atmospheric research program disciplines by: (1) identifying, planning and implementing approved current and future discipline support requirements including international and interagency cooperative activities; (2) maintaining a field measurement capability consistent with state-of-the-art requirements for correlative data precision and accuracy; and (3) conducting independent intercomparisons of remote and in situ sensor measurements.

W80-70380 **146-60-01**
Langley Research Center, Hampton, Va.
STRATOSPHERIC MEASUREMENT PROGRAM ACTIVITIES
J. M. Russell, III 804-827-2576
(198-30-02; 198-10-01; 198-20-03)

The overall objective is to develop, evaluate, and apply remote sensing technology to environmental monitoring of the stratosphere with the long range goal of providing this technology to those agencies charged with monitoring the stratosphere. Specifically, work will focus on developing and evaluating remote sensor technology for stratospheric measurements; on developing data interpretation techniques for satellite sensors; on developing techniques for correlating ground, aircraft, rocket, balloon, and satellite data; and on using available analytical models to expand existing and future data sets and provide the rationale for future measurement sets.

W80-70381 **146-60-02**
Wallops Station, Wallops Island, Va.
SOUNDING ROCKET SUPPORT FOR NIMBUS-7 AND SAGE
L. C. Rossi 804-824-3411
(146-30-04)

This effort is directed toward acquiring, reducing, analyzing and documenting correlative ozone, nitric oxide, atmospheric temperature, pressure and density and solar spectral irradiance in situ data from a variety of geographically located sounding sites during the Nimbus-7 SBUV, LIMS, SAMS and SAM II and SAGE sensor missions and participating in any discussions of the intercomparison of these independently acquired in situ data with that acquired by these satellite sensors during their respective data validation programs.

W80-70382 **146-60-02**
Langley Research Center, Hampton, Va.
ENVIRONMENTAL MONITORING RESEARCH SATELLITE MISSION STUDIES
Edwin F. Harrison 804-827-2977
(146-20-01; 198-30-02)

The objectives are to perform mission analyses, flight simulations, and experiment definition studies for advanced flight programs aimed at remote measurements of atmospheric and oceanic environmental parameters. Orbital analysis, along with data sampling simulations, will be conducted to determine the spatial and temporal coverage capabilities of various satellite experiments in meeting the measurement requirements established by scientific and user groups. In particular, trade-off analyses between shuttle launch time, orbit inclination, and altitude will be made to maximize the geographical coverage of atmospheric spacelab experiments such as the Space Lidar and the Laser Heterodyne Spectrometer. Statistical sampling analyses will be conducted to define optimum scan modes and operation duty cycles for the experiments selected for the Upper Atmospheric Research Satellite. A study will be undertaken to determine the feasibility of extending the current capabilty of solar occultation (SAGE) in order to measure additional key stratospheric constituents. Sensor concepts and mission approaches will be analyzed for various ocean and coastal zone experiments proposed for the National Oceanic Satellite System.

Space Processing

W80-70383 **179-20-55**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADVANCED CONTAINERLESS PROCESSING TECHNOLOGY
T. G. Wang 213-354-6331
(179-70-10)

The primary long-range objective of this task is to study and advance the positioning and manipulation capability of a high temperature acoustic chamber. A flight version of this module which would be flown on Spacelab would be used for processing and material science studies of materials in a containerless and zero-gravity environment. Presently JPL is under contract to develop a high temperature ACPM for early OSTA shuttle flights. However, many important facets of high temperature containerless processing technology have not yet been established, and some of the more sophisticated processing technology required for future shuttle flights is not available today. Detailed experimental and theoretical studies of containerless processing technology to be performed in this task will enable us to meet stringent requirements in the future. The objectives to be addressed in FY-80 include laboratory and theoretical studies to: (1) study the acoustic dynamic pressure and attenuation of a rectangular chamber as a function of a variety of physical parameters; (2) develop various acoustic frequency locking techniques; (3) investigate other acoustic geometries and devices which may improve sample manipulation capabilities; (4) study the molecular absorption loss process in various ACPM gases; and (5) compare the measurements with theoretical models developed under this task. In addition, the existing KC-135 acoustic positioning module will be used to develop methods to promote mixing of two or more substances in zero-g using the acoustic module, study and refine techniques for degassing liquid and molten samples by rotating the sample at any one of the three orthogonal axes, and provide potential outside users a facility with which to perform precursor experiments in a zero-g containerless environment.

W80-70384 **179-20-55**
Marshall Space Flight Center, Huntsville, Ala.
CONTAINERLESS PROCESSING
J. R. Williams 205-453-5961

The objective of this task is to develop the rationale and methodology for development of a comprehensive containerless processing program to be carried out in space. Several possible applications for containerless processing have been identified. These include: high-temperature properties measurements, wall-less melting and solidification studies, controlled shaping of melts, and the control of bubbles and liquid droplets. A number of suspension techniques have been conceived that can provide a limited capability to process in a containerless fashion on the ground or in aircraft. These capabilities will be developed to the fullest extent in order to understand the limitations of technology, define appropriate flight experiments, and to verify and characterize sample handling and positioning techniques for use in space. In addition, measuring the properties of containerless melts will require the development of new and unique instrumentation techniques.

W80-70385 **179-20-57**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FUSION TARGET TECHNOLOGY STUDY
T. G. Wang 213-354-6331

The primary objective of this RTOP is to utilize the unique zero-g environment provided by space to conduct fundamental studies of the physical processes that are associated with the production of inertial confinement fusion target shells. In order to produce the high quality fusion shells that are required, three fundamental physical processes must be understood: spheroidization of the shell, bubble centering, or shell wall uniformity, and adiabatic expansion and contraction of the molten pellet. In addition, during cooling and solidification of the molten shell, nonuniform temperature distribution within the material can produce nonsphericity and nonconcentricity of the shell through the dependence of physical properties upon temperature. These processes must also be understood. Unfortunately, the present pellet manufacturing technique cannot be used to study these processes separately. Attempts to conduct experiments on the dynamics of liquid bubbles (molten pellets) in laboratories are limited by insufficient pellet size for accurate observation, limited time for experiment, and the strong coupling between the two parameters, time and temperature, which precludes separation of the fundamental processes. The work described here will avoid these limitations and enable detailed study of each of the important processes through use of the low-gravity environments collectively available within the KC-135 aircraft facility, in certain drop towers (TBD), in the simulated zero-g environment provided by a neutrally-buoyant immiscible system, and in an acoustic levitation system. The primary activities of this task in the next year are to (1) study the bubble centering force as a function of various parameters, (2) study the instability associated with the adiabatic expansion and contraction, (3) study the Rayleigh instability of an annular jet and of two concentric annular jets, (4) develop Earth-based containerless fusion target fabrication facilities for correlating zero-g and Earth-based results, and (5) conduct theoretical calculations on jet stability, bubble dynamics and centering forces.

W80-70386 **179-27-62**
Marshall Space Flight Center, Huntsville, Ala.
THERMAL AND ENVIRONMENT CONTROL TECHNOLOGY
J. R. Williams 205-453-5961

The objective of this task is to develop a base of heat transfer, thermal control, and fluid management technology applicable to the needs of materials processing in space (MPS) experiment program. Performance requirements for MPS research investigations will be established by analysis of previous MPS research, MPS proposals, and envisioned MPS research. State-of-the-art and advanced techniques of research will be analyzed and adapted for use in space. Concepts for MPS research equipment responsive to MPS research requirements will be developed. These concepts will be refined and supported by laboratory simulations of key equipment components and techniques, breadboard test, ground-based space simulations, and, where necessary, proof-of-concept flights.

W80-70387 **179-28-62**
Marshall Space Flight Center, Huntsville, Ala.
MPS INSTRUMENTATION, CONTROL, AND DATA SYSTEM TECHNOLOGY
J. R. Williams 205-453-5961

The objective is to develop new instrumentation and data analysis technology in support of the materials processing in space program. Technology deficiencies are identified and requirements derived from various sources within the MPS Program, i.e., ongoing flight experiments, flight hardware development, supporting Research & Technology and Requirement Definition Groups (RDG's). These requirements define the objectives of the various development activities. A wide scope of theoretical and experimental (including breadboard development) efforts are conducted in order to provide the development support for techniques required for the investigations in the MPS Program.

W80-70388 **179-40-62**
Marshall Space Flight Center, Huntsville, Ala.
AR&DA SUPPORT
J. R. Williams 205-453-5961

The objective is to provide the necessary management, consulting and supporting effort to assure a meaningful and efficient research, technology, and definition effort for the MPS program. As the NASA Project Management Center for the MPS program, MSFC will provide the necessary professional and supporting manpower to manage and to direct the MPS research, technology, and definition effort. Supporting MSFC in this role, consulting and program support effort will be provided by select scientists from universities and industry who are recognized specialists in their specific physical and biological science disciplines. This support will be organized into committees and ad hoc groups, representing the various areas of interest which will meet throughout the year to assure continuing support and guidance.

W80-70389 **179-60-62**
Marshall Space Flight Center, Huntsville, Ala.
COMMERCIAL MATERIALS PROCESSING IN SPACE
Richard L. Brown 205-453-4880

The objective is to foster commercial uses of MPS technology in ways which will lead to new or improved materials processes on earth and in space, and thus to public benefits. The approach to be continued through FY-80 entails: (1) contact with private firms and other non-NASA government agencies to acquaint them with MPS; represents commercial interest internal to NASA; (2) analysis of government/industry relationships affectng commercial participation in MPS; (3) formulation of a program for joint endeavors between NASA and private firms; (4) formulation of procedures for use of government-owned MPS equipment and facilities by private concerns; (5) preparation and dissemination of data and informational materials; and (6) assistance to private concerns in the formulation of MPS experiments and demonstrations. In FY-81, this RTOP will provide for selected analysis and research tasks to be accomplished by universities, research institutes, and inhouse personnel. Tasks will be specifically directed at generating interest in MPS on the part of industrial research personnel.

W80-70390 **179-70-10**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ACOUSTIC CONTAINERLESS PROCESSING MODULE II (ACPM)
D. Kerrisk 213-354-2566
(179-20-55; 179-80-30; 179-20-57)

The objective is to develop and demonstrate a breadboard acoustic containerless processing module which meets a set of functional requirements to be developed by the ACPM science working group. The requirements will include maximum temperature, sample rotational capability, viewing requirements, isothermality requirements, cooling rates, and measurement accuracies. Once the SWG has defined the functional requirements of the ACPM, a design study will be conducted to tailor the previously developed design to these requirements, and to identify the major areas of technical uncertainty in the design. These areas are likely to include: (1) materials properties at ACPM maximum temperature, (2) materials survivability at rapid cooling rates, (3) survivability of reflective coatings at elevated temperatures, (4) optical and/or ultrasound sample position detection feasibility, (5) chamber thermal losses, (6) acoustic losses and distortions, and (7) acoustic control during heating and cooling. A technology evaluation program will be initiated to determine whether the functional requirements can be met and where present technology limitations preclude their being met. The outputs of this effort will be iterated through the SWG to produce a meaningful and achievable set of functional requirements for a first ACPM. To demonstrate that the functional requirements can be met, a breadboard ACPM will then be built and tested.

W80-70391 **179-70-62**
Marshall Space Flight Center, Huntsville, Ala.
DEFINITION STUDIES
E. C. McKannan 205-453-0542

The objective is to define the overall requirements and implementation approach for new hardware systems needed to accomplish Materials Processing in Space (MPS) program objectives. A precise, complete, and clear compilation of the science and/or engineering performance requirements and the hardware implementation approach will be developed for each hardware system. Through formal coordination and working sessions with the user community, a comprehensive formulation of scientific and technical requirements will be established for each hardware system. Based on these requirements, Phase A and Phase B definition studies will be performed as applicable to define the implementation approach for each hardware system. For the most part, the definition studies will be accomplished by hardware contractors supported by universities, research institutes, and inhouse personnel as required. The studies are needed in order to collect and assess all pertinent requirements, and to define cost-effective hardware systems which can accomplish the stated requirements. The required technology advancement and associated costs will be assessed and sufficient data will be developed to allow trade studies and optimizations to assure a balanced approach for each system considering technical and programmatic objectives.

W80-70392 **179-80-10**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INFRARED DETECTOR MATERIALS PREPARATION
J. Zoutendyk 213-354-3214
(179-02-62; 179-03-62)

This research program is aimed at the exploitation of the zero-gravity space environment for the growth of single-crystal materials for infrared (IR) detectors, having characteristics unattainable in an Earth-gravity growth configuration. The materials GaInSb and PbSnTe chosen for this research work are uniquely suited for the demonstration of the possible advantages of space processing in the areas of melt- and vapor-phase crystal growth. These same materials are of primary interest for the fabrication of IR detector arrays which will be required by NASA for future thermal IR Remote sensing systems. The program will draw upon the crystal-growth technology available at industrial and university laboratories and undertake specific investigations in collaboration with the technical personnel at these institutions. In the course of this work, space-based experiments will be defined in an effort to demonstrate if detector material limitations can be circumvented through the use of zero-gravity. Ground-based experiments on solute diffusion.growth of GaInSb single crystals will include magnetic damping of convection currents in the melt. Vapor-phase growth of PbSnTe in a closed-tube configuration will be investigated experimentally and theoretically in terms of the effect of gravity-aided convection.

W80-70393 **179-80-30**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
GLASS RESEARCH
M. C. Weinberg 213-354-2869

This activity relates to the materials processing in space effort. It consists of four distinct, but related, efforts aimed at dealing with fundamental and practical questions pertaining to the processing of glasses in space. Studies (1) & (2) focus on the use of MOD (metal organic derived) or gel materials for glass preparation in space. Effort (1) is an investigation aimed at elucidating the properties and behavior of MOD glasses; specifically, the phase separation and crystallization behavior. This program will be performed at JPL. Study (2) is an applied research effort aimed at producing ultrapure optical fibers from such gel glasses, and is being pursued at Battelle Memorial Institute. Programs (3) & (4) pertain to the removal of gas bubbles from glass in a microgravity (space) environment. Study (3) is being performed at Clarkson College, while (4) is being carried out at JPL. (1) The primary goal of this work is to contrast the behavior of metal organic derived (MOD) and batch prepared glasses. Particular emphasis will be placed upon a comparative study of the glass in glass phase separation in these systems. (2) In this study the sol-gel process applied to sodium-borsolicate glasses, permit space environment containerless glass melting. Objectives are: Develop gel-preparation and melting parameters in ground-based experiments; develop ultrapure borosilicate glasses, using ultrapure starting materials and the sol-gel process. These ground-based experiments will be done in containers and in containerless (levitated) systems; and fiber-draw from prepared ultrapure glass canes and determine total optical-loss characteristics. (3) The objectives of this work are to investigate thermocapillary flows and thermocapillary bubble motion and multibubble interactions in model fluids and molten glasses in space, and to investigate bubble centering and other physical phenomena involved in the formation of hollow glass shells. (4) The general objectives of this program are to find procedures to produce bubble free glass in space and to utilize the unique environment of the space shuttle to gain information which would be beneficial to earth processing of glasses.

W80-70394 **179-80-40**
Marshall Space Flight Center, Huntsville, Ala.
BIOSEPARATION PROCESSES
J. R. Williams 205-453-5961

The bioseparations program is a research activity currently being pursued to exploit the unique environment of space, namely, low gravity, to enhance the purification of valuable biological products. Many substances of great clinical or research importance cannot be prepared synthetically but must be extracted from living tissue. Some others can be synthesized in the laboratory, but only in contaminated form which then requires further purification. These substances exist within such complex media as blood, urine, tissue homogenates, or nutrient culture media, and extraction in homogeneous form is exceedingly difficult; moreover, the methods used must be gentle if the product's biological activity is not to be destroyed. Currently used methods for purification are expensive, tedious, and low-yield.

W80-70395 **179-80-50**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
BIOSEPARATION
Alan Rembaum 213-354-3189

The chief obstacle to the study of cell biology is the problem of obtaining pure populations of different kinds of living cells from a given organ. At present, there are no satisfactory techniques to achieve cell separation of relatively large numbers of cells. One of the most promising possibilities for a solution to this problem is the separation and purification of cells by electrophoresis in the space environment. Past efforts to separate cells of similar electrophoretic mobility were unsuccessful. The long term goal is to demonstrate a new concept for the electrophoretic separation of immunologically labeled biological cells and to show that this separation is improved in space where sedimentation and convective flows due to gravity are minimized. Work initiated in FY-78 towards this goal yielded results which support the new concept. It was shown that cells of identical electrophoretic mobility could be separated using the new immunological labeling because the labeled cells exhibited reduced electrophoretic mobility. Therefore, large scale electrophoretic separation of cell subpopulations impossible to achieve in the past has a good probability for success in the near future. The specific goals are: (1) successful electrophoretic separation of human or murine lymphocytes subpopulations by immunological labeling of a specific subpopulation of cells with neutral or positively charged microspheres; (2) demonstration of successful large scale separation of B lymphocytes in flight hardware; and (3) removal of microspheres from labeled cells and determination of the viability. It is expected that the new concept will permit large scale electrophoretic separation at zero g of systems difficult to separate on Earth.

W80-70396 **179-80-50**
Marshall Space Flight Center, Huntsville, Ala.
FLUID AND CHEMICAL PROCESSES IN LOW GRAVITY
J. R. Williams 205-453-5961

The primary objective is to develop a comprehensive program that utilizes the unique low gravity environment of space to study fluid and chemical processes that are complicated by gravity driven flows or limited by buoyancy effects. The secondary objective is to develop an understanding of the behavior of fluid in response to the low levels of acceleration and rotation inherent in the spacecraft environment. A number of potentially interesting

space experiments have been identified that can effectively utilize space to solve problems of interest to research and industrial chemists. Some of these experiments can be simulated or approximated by laboratory techniques using rotating or neutral buoyancy systems. This initial phase of this RTOP will be used to establish the limitations of ground based techniques in order to establish the rationale for the envisioned flight experiments and to assess the effect of fluid disturbances caused by vehicular motions.

W80-70397 **179-80-60**
Marshall Space Flight Center, Huntsville, Ala.
SOLIDIFICATION PROCESSES
J. R. Williams 205-453-5961

The objective is to provide a foundation of scientific and technical knowlege associated with solidification processes, how these processes are influenced by the space environment, and how the space environment can be used to control the structure and properties of solidified materials. A wide scope of theoretical and experimental investigations will be conducted associated with low gravity and/or containerless solidification of metals, multi-phase alloys, including miscibility gap, eutectic and peritectic materials, dispersions, composites, glasses, metal foams, and metastable or amorphous alloys. Specifically, these investigations will include: (1) thermal and solutal convection and its influences on crystal growth, solidification, and phase separation processes; (2) agglomeration, coalescence, and sedimentation influences in the prparation of monotectic alloys and composite materials; (3) solidification processes in supercooled and hypercooled melts, and the preparation and properties of metastable and amorphous alloys; (4) structure and properties of materials solidified in a containerless or low-gravity environment; and (5) the application of such solidication processes to science and technology.

W80-70398 **179-80-70**
Marshall Space Flight Center, Huntsville, Ala.
CRYSTAL GROWTH PROCESSES
J. R. Williams 205-453-5961

The objective is, when taken together with the associated flight experiment program, to provide a comprehensive attack on advancing the state-of-the-art in the growth of single crystalline materials and in particular to provide the basis for processing these materials in space. In the near future, the program is designed to concentrate on solid solution semiconductors, float zone processing, and basic studies in support of these as well as approved flight experiments. Tasks included in this RTOP span the various facets of the semiconductor area including growth phenomena, characterization, and process technology, as well as one study to determine materials needs for specific devices.

Upper Atmospheric Research

W80-70399 **147-10-00**
National Aeronautics and Space Administration, Washington, D.C.
UPPER ATMOSPHERIC RESEARCH - FIELD MEASUREMENTS
S. G. Tilford 202-755-3766

The principal goal of the field measurements program is to provide the data required for development of an organized, solid body of knowledge of the physics, chemistry, and dynamics of the Earth's stratosphere and mesosphere. Specific measurement goals are (1) improvement and validation of photochemical models; (2) determination of the location and strengths of the sources and sinks for upper atmospheric constituents; (3) improvement of understanding of upper atmospheric dynamics and transport; (4) determination of the locations and strengths of troposphere-stratosphere exchanges; (5) observations of changes in the distribution and total amount of ozone; (6) determination of the mean distribution of long-lived species; and (7) determination of solar UV variations and of the accuracy of radiative transfer calculations. The data obtained are required for improvement and validation of theoretical models and for assessment of the effects of natural and man-related perturbations on the atmosphere. A variety of in-situ and remote sensing techniques are used with ground-based, balloon, aircraft, rocket, and satellite platforms. Development or extension of experimental techniques are required to meet some of the measurement goals, and coordinated measurements of key parameters are emphasized due to the highly coupled nature of atmospheric processes.

W80-70400 **147-10-01**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - FIELD MEASUREMENTS
R. D. Hudson 301-344-6358

The objectives are: (1) determine the specific local chemical and physical interactions in the atmosphere by a combination of theoretical studies and coordinated in situ measurements campaigns from balloon, rocket and aircraft platforms; (2) investigate the variations and perturbations of the chemical and physical state of the atmosphere, i.e., variations with altitude, solar conditions, season, latitude, and perturbations from volcanoes, tropical storms, industrial and agricultural activity; and (3) develop and calibrate selected instruments for local and remote investigations of the atmosphere. The approach will consist of the following activities: (1) develop a balloon borne LIDAR system, a Michelson interferometer spectrometer, an infrared heterodyne spectrometer, submillimeter radiometers, and a photoionization mass spectrometer to measure the concentrations and diurnal variations of trace stratospheric species; (2) perform laboratory studies of the resonance fluorescence of stratospheric species by single and two photon excitation in support of the LIDAR experiments; (3) measure ozone and the direct and diffuse components of the solar flux in the stratosphere and mesosphere; and (4) perform multi-instrument, coordinated measurements of minor species in the stratosphere and mesosphere.

W80-70401 **147-10-01**
Langley Research Center, Hampton, Va.
EVALUATION OF ADVANCED SENSOR CONCEPTS FOR SATELLITE MONITORING OF THE STRATOSPHERE
M. P. McCormick 804-827-2466

The objective is to expand advanced satellite sensor development by maintaining and continuing to expand balloon-borne spectrometer measurements of UV-visible solar Earth-limb extinction. Additional objectives include improving the measurement capabilities of the Univ. of Denver balloon-borne spectrometer for stratospheric species measurements, showing the usefulness of these techniques and measurement sets through their application in model development, stratospheric-tropospheric exchange studies, inputs to radiation codes and remote sensor developments such as an advanced solar extinction radiometer (SER); and assessing and evaluating present data from SAM 2, and SAGE, and providing essential data for the specifications of SAGE 2. At Langley, the SER development program is being supported by three RTRs. Under this 198 program, balloon-borne spectrometer measurements are made in the solar extinction geometry. These data are analyzed under the 146 program that supports Dr. Goldman's analysis at the Univ. of Denver. This analysis provides spectrometer specifications for future balloon flights, throughtput analysis via measured spectra for SAM 2, SAGE, and SAGE 2, and specifications for conceptual design of advanced space sensors. The conceptual satellite sensor design studies are supported by the 690 program under contract to Bell Aerospace Corp.

W80-70402 **147-10-02**
Lyndon B. Johnson Space Center, Houston, Tex.
VERTICAL PROFILES OF OZONE AND TOTAL CHLORINE IN THE UPPER STRATOSPHERE
D. E. Robbins 713-483-5039

The objectives of this RTOP are (1) determine ozone concentration profiles over the range 10km to 44km for the purpose of establishing natural variations and baseline data for the 1978/1979 time period; (2) provide simultaneous measurements of ozone for correlation with measurements of stratospheric species made by other investigators; and (3) obtain measurements

of total chlorine (regardless of molecular form) in the range 20km to 44km, and study variations to determine effects due to photochemistry and atmospheric dynamics.

W80-70403 **147-10-04**
Ames Research Center, Moffett Field, Calif.
INSTRUMENT SYSTEMS FOR MEASUREMENT OF TRACE GAS CONSTITUENTS IN THE STRATOSPHERE
I. G. Poppoff 415-965-5027

The objective is to develop, flight test, and utilize airborne instrument systems for measurement of important gas species in the stratosphere. Several multiple species instrument systems for making accurate measurements of the minor gas constituents in the stratosphere are being developed for integration onboard aircraft and balloon platforms. The ability to make coordinated simultaneous measurements on a routine basis is being emphasized. Techniques such as chemiluminescence and IR spectroscopy are being employed. Goals will be to study the geographic and seasonal and diurnal variations of the measured species and respond to and participate in cooperative stratospheric rendezvous and collaborative experiments.

W80-70404 **147-10-06**
Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF NEW INSTRUMENT SYSTEMS FOR DETECTION OF TRACE CONSTITUENTS IN THE STRATOSPHERE
I. G. Poppoff 415-965-5027

The objective is to develop new airborne instrumentation to measure trace gas constituents in the stratosphere. This includes performing applied research necessary to develop fundamental principles and sensor techniques to a level of feasibility for making routine inflight measurements. A study of many new techniques for measuring trace gas constituents in the stratosphere has been in progress for several years. This study has yielded promising results for several species such as the halocarbons, methane, chlorine compounds, and hydroxyl radicals. Airborne systems based on these techniques are being developed for in situ measurements.

W80-70405 **147-10-06**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STRATOSPHERIC RESEARCH, FIELD MEASUREMENTS PROGRAM
W. T. Huntress 213-354-2140
(198-20-03)

The overall objective of the JPL upper atmospheric measurements program is to obtain measurements needed for understanding the basic physics, chemistry, and transport of the upper atmosphere. Highest priority is given to those measurements necessary for assessing the extent to which man's technological activities may affect the upper atmosphere. At present five techniques are included in the program: (1) infrared interferometry, (2) infrared heterodyne radiometry, (3) millimeter and submillimeter radiometry, (4) pressure modulation infrared radiometry (in collaboration with Oxford University), and (5) laser absorption spectroscopy. The first four of these are remote sensing techniques with instruments having already been developed for balloon or aircraft. The fifth technique measures absorption between a balloon gondola and lowered reflector; an instrument is now being developed. A major FY-80 goal of the JPL program is to fly the four remote sensing instruments mentioned above together on a multisensor balloon gondola (already constructed) to simultaneously obtain many measurements needed for understanding stratospheric chemistry, particularly the chlorine cycle of ozone destruction: HCl, ClO, ClONO2, CH3Cl, CFCl3, CF2Cl2, HF, H2O, H2O2, O3, CH4, NO2, NO, N2O, HNO3, and possibly HO2, HOCl, HO2NO2, N2O5, and COS. Longer term goals of the program include continued multi-sensor balloon measurements as needed and certain measurements (e.g. ClO) with individual sensors. When appropriate, these measurements will be coordinated with related measurements by other groups. Development of new instruments to measure additional species (e.g. submillimeter radiometry for emission measurements of OH, HCl, atomic O, HOCl and other species; improved laser radiometry for HO2 and other species) is also included in the program. In addition to providing instruments for balloon and aircraft measurements these developments will be valuable for future instruments to perform global monitoring from the space shuttle and free-flier satellites.

W80-70406 **147-10-10**
Ames Research Center, Moffett Field, Calif.
AIRBORNE PLATFORM SUPPORT FOR STRATOSPHERIC SAMPLING PROGRAM
I. G. Poppoff 415-965-5027
(198-10-04; 198-10-06; 198-30-02; 146-10-04)

The objective of this research is to obtain observational data regarding the vertical transport into the stratosphere of tropospheric species (such as CFM's, N2O, sulfur compounds, and water vapor) and the latitudinal and downward transport of stratospheric species (such as NOx, ClOx, O3, HNO3 and aerosols). Of interest, currently, is the important vertical transport that is thought to occur in tropical meteorological events such as active intertropical convergence zone (ITCZ) periods and Asian monsoons. Studies of possible upward transport associated with mid-latitude jets and cyclonic activities will also be considered. The approach is to form experiment working groups composed of theoreticians and experimenters to design the appropriate observational missions, to participate in making and analyzing measurements, and to evaluate the results of the missions. Inasmuch as the regions of interest are the upper troposphere and the lower stratosphere, aircraft are excellent platforms. Typical experiments use a medium-altitude aircraft, such as the CV-990 or Learjet, and a high-altitude aircraft, the U-2; each of the aircraft carries several instruments in order to measure all the species of interest. Ancillary meteorological data are collected by special balloon soundings, from neighboring weather stations, and from meteorological satellite coverage.

W80-70407 **147-10-12**
Wallops Station, Wallops Island, Va.
UPPER ATMOSPHERIC RESEARCH - TRANSPORT BEHAVIOR
F. J. Schmidlin 804-824-3411
(198-10-01; 198-30-02; 198-10-10)

The objectives contribute to the understanding of the complex processes which influence the large-scale atmospheric behavior; investigate retrieval techniques for satellite investigations dealing with the motion behavior of the atmosphere and compare with a set of measurements to be obtained between the surface and 90 km; and compare data obtained with local reference atmosphere.

W80-70408 **147-20-00**
National Aeronautics and Space Administration, Washington, D.C.
UPPER ATMOSPHERIC RESEARCH - LABORATORY STUDIES
S. G. Tilford 202-755-3766

The principal goals of the laboratory studies program are (1) to provide the kinetic, photochemical, and spectroscopic data needed for developing an organized, solid body of knowledge of the physics, chemistry, and dynamics of the Earth's upper atmosphere and (2) to support the field measurement and theoretical studies programs. Laboratory measurements of atmospheric reaction and photo-process rates, particularly those related to ozone photochemistry, and spectroscopy of atmospheric constituents using conventional and new laser-related techniques are emphasized. Advanced laboratory techniques are developed to permit study of highly reactive species under upper atmospheric conditions. Laboratory studies of advanced sensor concepts and techniques are focused upon potential development of the highly sensitive instruments needed for upper atmospheric field measurements.

W80-70409 **147-20-01**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - LABORATORY MEASUREMENTS
R. D. Hudson 301-344-6358

The objective is to measure chemical kinetic rate coefficients

of importance to the stratosphere and mesosphere, and to evaluate current knowledge of the upper atmosphere. The laboratory effort in chemical kinetics uses existing equipment of unique capability for the purpose of measuring absolute rate constants of reactions of importance in current models of the stratosphere. Rate constants are measured as a function of temperature and pressure and under conditions in which the number of atoms is much less than the number of molecules. The second objective is achieved by holding periodic workshops at which reports are prepared assessing the current state of knowledge of the stratosphere.

W80-70410 **147-20-03**
Ames Research Center, Moffett Field, Calif.
QUANTITATIVE INFRARED SPECTROSCOPY OF MINOR CONSTITUENTS OF THE EARTH'S STRATOSPHERE
R. W. Boese 415-965-5501
(198-10-04)

Remote detection and measurement of stratospheric species via spectroscopic techniques is being routinely employed to develop a better understanding of this portion of our atmosphere and man's effect upon it. Proper interpretation of these measurements relies strongly on having the correct laboratory data. The objective of this work is to obtain laboratory measurements of basic molecular parameters, such as rotational line intensities and half-widths, absorption band intensities, vibrational and rotational constants, vibration-rotation interaction constants, line position measurements including pressure induced shifts, and Franck-Condon factors. The determination of these parameters, and their dependence on pressure and temperature, will be obtained by using long path gas cells, cooled and heated cells, and high resolution interferometers and spectrometers.

W80-70411 **147-20-03**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION INFRARED MEASUREMENTS OF ATMOSPHERIC TRACE GASES
R. S. Rogowski 804-827-2818
(176-10-32; 506-18-23)

High resolution infrared spectra will be measured for atmospheric trace gases to obtain spectral parameters required for interpretation of data from remote sensing instruments. Diode lasers which are narrow band and tunable will be used as sources so that complex molecules can be studied at high resolution with minimum distortion of line shapes. Line positions, strengths and broadening coefficients will be measured and absorption lines will be identified by the quantum level involved in the transition. Transient and unstable gases can be generated in a flow/reactor system that has been successfully operated for high resolution infrared studies of ClO. This facility can be used to produce other gases of importance to stratospheric chemistry by simply changing the reactant species. The systems will be used to synthesize other gases and is currently being applied to the production of ClONO2 which may be a sink for Cl and NOx. Species concentrations in the absorption cell are monitored by UV absorption measurements which can be made simultaneously with the IR observations. Following the measurement of ClONO2 IR spectra, the facility will be used to generate and measure spectra of HO2, H2O2 and HOONO2.

W80-70412 **147-20-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CALIBRATION SPECTRA
W. B. DeMore 213-354-2436

A program of laboratory studies will be conducted in: chemical kinetics of the upper atmosphere, photochemistry of the upper atmosphere, data survey and evaluation, and ionic processes in the upper atmosphere. The program will be designed to provide data needs and guidance for both chemical models and field measurements. Primary emphasis will be on the acquisition of kinetic data including reaction rate constants, temperature, dependences, and product formation. Photochemical quantum yields, absorption cross sections, and product distribution will be measured. A broad base of data knowledge in all the foregoing areas will be maintained through literature surveys and through contact with other groups active in these areas. Laboratory studies will be conducted on ionic processes in the upper atmosphere, in particular ion-molecule reactions important in the natural and perturbed mesosphere.

W80-70413 **147-30-00**
National Aeronautics and Space Administration, Washington, D.C.
UPPER ATMOSPHERIC RESEARCH - THEORETICAL STUDIES
S. G. Tilford 202-755-3766

The principal goals of the theoretical studies program are to (1) provide the framework for developing and understanding an organized, solid body of knowledge of the physics, chemistry, and dynamics of the Earth's upper atmosphere, (2) analyze important data from upper atmospheric flight programs, and (3) predict and assess the effects of natural and man-related perturbations on the atmosphere. Development and utilization of 1-,2-, and 3-dimensional models simulating the upper atmosphere provide the mechanism for relating measurement data to physical concepts and allow predictions about atmospheric phenomena which are not readily measured. Data analysis efforts allow efficient handling and inversion of large measurement data sets. Prediction and assessment activities utilize the modeling and analysis capability to provide advance knowledge of potentially hazardous threats to our atmospheric environment. Support of timely workshops and symposia to assess our current state of knowledge and future needs in upper atmospheric research and support of information transfer and data catalogue efforts provide an on-going examination and summary of our progress in understanding the upper atmosphere.

W80-70414 **147-30-01**
Ames Research Center, Moffett Field, Calif.
MOLECULAR PROPERTIES OF STRATOSPHERIC CONSTITUENTS
D. M. Cooper 415-965-6213
(198-30-02)

The objective is to provide basic molecular data required to identify and measure absolute concentrations of trace constituents in the stratosphere. These data include spectroscopic parameters such as vibrational and rotational constants as well as radiative transition parameters such as absolute band strengths, integrated IR intensities, photodissociative cross-sections, and predissociative lifetimes for molecules of stratospheric importance such as ClO, NO, OH, HO2, and HOCl. These parameters will be determined by experimental and/or theoretical techniques. The experimental investigations will be performed in a shock-tube facility. Either absorption or emission measurements can be used to determine the desired spectroscopic and radiative parameters. The theoretical studies will use self-consistent field plus configuration-interaction calculations to determine electronic and vibrational wavefunctions and derived radiative parameters. In addition, a finite perturbation method will be used for the calculation of the integrated IR intensities.

W80-70415 **147-30-01**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - THEORETICAL STUDIES
R. D. Hudson 301-344-6358

The objectives are to provide the framework for developing and understanding an organized, solid body of knowledge of the physics, chemistry, and dynamics of the Earth's upper atmosphere, analyze data from upper atmospheric flight programs, and predict and assess the effects of natural and man-related perturbations on the atmosphere. The approach is: (1) to develop a simplified one dimensional model for sensitivity and error propagation analyses, (2) develop a diurnal, detailed chemistry, one dimensional models for studies of stratospheric photochemistry, (3) develop a zonal-mean wind two dimensional model to study latitudinal effects, (4) study the NIMBUS 4 and NIMBUS 7 ozone data to elucidate dynamical effects and global trends, and (5) use data from instruments on the Solar Maximum Mission to study mesospheric chemistry.

W80-70416 **147-30-02**
Ames Research Center, Moffett Field, Calif.
STRATOSPHERIC RESEARCH
I. G. Poppoff 415-965-5027
(198-20-03; 146-10-04)

The objective is to gain an understanding of the composition, structure, and dynamics of the Earth's stratosphere and mesosphere, and the important chemical and physical processes which occur there. Efforts will also be made to assess the effects on important stratospheric properties (e.g., ozone abundance and radiation balance) of man caused and natural perturbations. There will be collaboration with the academic community to advance new model development. Several types of chemical and dynamical models of the stratosphere have been or are being developed to provide improved descriptions of the complex processes which occur in the upper atmosphere. These models, which are each addressed to specific types of problems, contain varying degrees of complexity with respect to chemistry and atmospheric motions. Development will continue such that each one is optimized according to its potential applications to fundamental and applied problems. Collaboration with scientists in the academic community is continuing. This work on models includes development and application of three-dimensional dynamical/chemical models of the stratosphere (Ames and MIT) and computational support of a detailed aeronomical model (Harvard). Ab initio computations of molecular processes important to stratospheric photochemistry are also being carried out.

W80-70417 **147-30-02**
Langley Research Center, Hampton, Va.
STRATOSPHERIC THEORETICAL STUDIES AND SCIENCE DEFINITION ACTIVITIES
R. H. Tolson 804-827-2530

The objectives are to conduct theoretical studies of stratospheric phenomena, computational chemistry studies of reactive stratospheric molecules, and science definition activities for laser heterodyne spectrometer (LHS) missions. Specifically, theoretical studies will be performed of three-dimensional dynamics and chemistry, changes in temperature and constituents due to UV variability, and one-dimensional photochemistry including temperature coupling and scattering. Computational chemistry studies will focus on determining stability, reaction rates, and photolysis rates for short-lived species which are difficult to investigate experimentally. Scientific definition efforts will continue to develop scientific requirements for the LHS spacelab mission by performing parametric sensor sensitivity studies, analyze long path high resolution spectroscopic data, and identify correlative measurement strategies. The approach is to use existing analysis and computational capabilities to address the above areas of research. Such capabilities include one-, two-, and three-dimensional atmospheric models; a computational chemistry generalized valence bond program; and numerous programs for performing sensor sensitivity studies and experiment optimization studies.

W80-70418 **147-30-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THEORETICAL STUDIES/STRATOSPHERIC RESEARCH
S. S. Prasad 213-354-6423

The objective is to determine chemical response of the upper atmosphere to energetic particle precipitations during the solar particle events of Aug. 1972 and Nov. 1969. Our approach is theoretical and uses a comprehensive chemistry which includes several hitherto neglected but potentially important processes, such as HNO3 and HOx production due to ionic reactions and possible NO or N2O production due to N2 A cubed Sigma generated by the primary and secondary particles. We consider not only the main proton precipitation but also other geophysical events (e.g., the geomagnetic storms) that accompanied the intense event of Aug. 1972. Lateral transport is taken into account; thus this event is studied with the help of a 2-D model of upper atmospheric chemistry and dynamics. In the case of the milder event of Nov. 1969 only vertical transport will be considered. However, the availability of neutral atmospheric and ionic concentration measurements during this event will allow us to determine ambient total density, temperature and k sub eddy from observations, rather than from standard models. Unfortunately, uncertainties in dynamics and lack of measurements of neutral trace species other than ozone tends to under constrain the problem. Nevertheless, by careful comparison of the results from this study with the observed ozone reductions and results from previous studies we hope to evaluate the role played by specific physical-chemical processes (while other uncertain factors are kept fixed) we shall also try to identify opportunities, that particle precipitation events might possibly provide for uniquely testing atmospheric reaction schemes and/or validating remote sensing techniques (for rare species whose concentration under normal conditions may be below detection limit).

W80-70419 **147-30-03**
Lewis Research Center, Cleveland, Ohio.
GLOBAL ATMOSPHERIC SAMPLING PROGRAM (GASP)
Donald A. Petrash 216-294-6680

Atmospheric sampling of minor atmospheric constituents conducted under GASP was terminated on March 1, 1979. Sampling for ozone on two B-747's under an FAA reimbursable agreement (DOT-FA78 WAI-893) will continue through June, 1979. Objective of the FY-80 continuation of this RTOP will be to complete the data reduction, editing and inhouse analysis of the GASP measurements in order to make them available for continuing studies of atmospheric variability and transport. Changes in data editing procedures for the continuous data recorded during the last three months of the program will be implemented to remove instrument transients following calibration modes. This data can be utilized to parameterize mesoscale mixing and transport processes at mid-latitudes.

W80-70420 **147-30-04**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH SATELLITE (UARS) DEFINITION STUDY
R. A. Austin 301-344-6473

The UARS mission objective is to understand: (1) the mechanisms that control the upper atmosphere structure and variability; (2) the response of the upper atmosphere to natural and anthropogenic perturbations; and (3) the role of the upper atmosphere in climate. To achieve these objectives, the UARS will study the energy input and loss in the upper atmosphere, the global upper atmospheric photochemistry, the dynamics of the upper atmosphere, and the coupling processes among and between atmospheric regions. The objective of this RTOP is to perform the necessary studies that will explicitly define the two UARS spacecraft and their ground analysis requirements. GSFC will integrate the instruments (selected by AO in late FY-79) and the mission design of the mission needs statement and the preliminary execution phase project plan into the execution phase project plan. Documentation required for a FY-81 new start execution phase will be prepared. During FY-79, technical support will be provided to the Headquarters AO selection process, and study contracts will be issued to each chosen investigator in the Sept. - Nov. period. Contracts for alternate mission design concepts will be issued in FY-80. The results of these studies will be taken, and the execution phase project plan produced. By solving technological concerns early, the studies will ensure an on-schedule and within cost project.

W80-70421 **147-30-04**
Langley Research Center, Hampton, Va.
LASER HETERODYNE SPECTROMETER FOR SPACELAB
Frank Allario 804-827-2576
(506-18-23)

The objective is to perform a series of scientific investigations related to the chemistry and dynamics of the upper atmosphere through multiple reflights of the laser heterodyne spectrometer (LHS) experiment on spacelab. The LHS experiment will obtain vertical profiles of a variety of radical species (ClO, ClONO2, H2O2, HO2, HOCl, N2O5...) from 10 to 60 km with vertical resolution less then 2 km. Measurements from the LHS spacelab experiment have the potential to complement planned upper atmospheric investigations of ATMOS, HALOE, ERBS and UARS missions. The approach will be to develop, calibrate, and flight test on a high altitude aircraft, a 2-gas simultaneous LHS

brassboard instrument, and subsequently to develop, calibrate and flight test on spacelab an LHS experiment with the capability of simultaneous measurements of two or more gases in solar occultation.

W80-70422 **147-30-05**
Goddard Space Flight Center, Greenbelt, Md.
SPACELAB SCIENCE PAYLOAD DEFINITION FOR UPPER ATMOSPHERE
M. Dubin 301-344-5475

The objective is to define the experimental feasibility and approaches for investigations of the upper atmosphere from Spacelab. The investigation of the upper atmosphere from the shuttle - spacelab is based primarily on the remote sensing of emissions and absorption from the atmosphere. The methods are photometric, primarily in the infrared and microwave region as well as the ultraviolet and X-ray region. The observations, scanning the Earth's limb, require instruments with low noise and long focal length telescopes. The capacity of the shuttle to carry the large and complex instruments required, affords an approach incorporating instruments using cryogens, various combinations of detectors and combinations of instruments necessary to the investigation of the chemical and dynamic characteristics of the upper atmosphere. This RTOP involves instrument definition for a multiplicity of uses in the Spacelab program, with the present effort centered on infrared spectroscopy of limb emission.

Technical Consultation and Support Studies

W80-70423 **643-10-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
TECHNICAL CONSULTATION SERVICES
W. J. Weber 213-354-3845
(311-03-21; 643-10-02)

The objective is to ensure the growth of space applications by providing the technical basis and regulatory framework needed to obtain sufficient spectrum/orbit to meet current and projected requirements. The results of this work will be used by NASA to help determine its frequency and orbit requirements and to ensure compatibility between NASA flight programs and other space and terrestrial services. The results will also be used by NASA and other government agencies for the purpose of supporting CCIR and Administrative Radio Conferences; in making decisions on frequency/orbit utilization and assignments, ground-station and satellite approvals; and in providing for the growth of existing and new satellite services. The approach for this RTOP has been subdivided into five work units to reflect the diversity of the studies: (1) Spectrum management: this work unit pertains to those policy and allocation problems which arise in satellite communications and will continue to arise with the growth of new space applications. (2) Propagation: the propagation tasks will provide data necessary to estimate link performance for new space applications. (3) Orbit/spectrum utilization: this work unit contains tradeoff studies of those technologies which have a significant effect on the efficient use of available orbit and spectrum in space applications. (4) Technology assessment: this work unit will provide satellite system designers with the parametric information of critical technologies required for the development of new space applications. (5) System design concepts: new applications will be studied (coordinated with RTOP 643-10-02) from an overall communication systems design point of view.

W80-70424 **643-10-01**
Lewis Research Center, Cleveland, Ohio.
TECHNICAL CONSULTATION SERVICES
R. E. Alexovich 216-433-6689

This activity will provide technical consultation services support in the areas of high powered broadcast satellite technology and fixed service communications satellite technology in preparation for the 1983 RARC (Regional Adminstrative Radio Conference); perform overall system studies to evaluate alternate system configurations for broadcasting and fixed satellites; and identify requirements of future systems and develop system concepts and approaches. Studies and technical assessments will be conducted, and where necessary, measurements will be conducted in the areas of high powered broadcast satellite technology and fixed service communications satellite technology, culminating in technical papers required for CCIR SG's on frequency utilization and broadcasting (sound/television). In preparation for the 1983 RARC, perform in house studies, and contact studies where necessary, to support possible United States positions and to determine the tradeoffs associated with each position. Principle emphasis will be given to keeping available a range of options for broadcasting satellite implementation.

W80-70425 **643-10-02**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS SATELLITE NEW APPLICATION NOTIFICATION STUDIES
J. J. Ward 216-433-4000
(643-10-01; 650-20-16)

The objective of this effort is to establish a preliminary definition of a satellite based communications system for the delivery of narrowband services. Through a combination of inhouse and contracted efforts, system economic and institutional viability will be assessed. Studies will specifically address: conceptual system description for the delivery of thin-route fixed and mobile services; system and user technical and functional requirements; network configuration; modulation and access requirements; frequency and bandwidth requirements including sharing analysis. Market factors shall be treated parametrically pending the results of the narrowband market demand assessment studies to be conducted under RTOP 650-20-16.

W80-70426 **643-10-02**
National Space Technology Labs., Bay Saint Louis, Miss.
COMMUNICATIONS SATELLITE APPLICATIONS TO RURAL EMS
R. B. Hegwood 601-688-2135
(643-10-01)

The objectives are to conduct a comprehensive experiment in the application of satellite communication technology to rural and remote health care in Alabama, Mississippi, and Louisiana; perform a technical, economic, and functional performance evaluation of the experiment; perform a functional and technical needs assessment; define network operational problems, and provide cost comparison of terrestrial VS satellite VS hybrid systems. This experiment is a joint effort of the National Space Technology Labs. (NSTL), The Southern Regional Medical Consortium (SRMC) and the National Highway Traffic Safety Administration (NHTSA) and is one element of an Integrated Mobile Experiment. NSTL will provide technical support to the SRMC for the implementation, operation and evaluation of the satellite based mobile emergency communications system that will provide for emergency notification, vehicle dispatch and two-way voice and biomedical data communications between paramedics and hospital physicians in the three state area of Alabama, Mississippi and Louisiana. Data from this experiment will provide the basis for a comprehensive medical economic and operational evaluation that will facilitate planning for a future mobile satellite capability.

W80-70427 **643-10-02**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMMUNICATIONS SATELLITE NEW APPLICATIONS NOTIFICATION STUDIES
W. J. Weber 213-354-3845
(643-10-01)

The technical objectives include aid in providing for the growth of existing satellite services and new communication satellite applications, and ensuring compatibility of NASA's communications flight programs with other space and terrestrial services. The technical approach will include conceptual description, user functional requirements, technical requirements, systems description, frequency and bandwidth requirements, cost

effectiveness, system tradeoff, and sharing studies required to demonstrate compatibility with existing or planned services.

Applications Systems Analysis and Studies

W80-70428 **644-10-01**
Wallops Station, Wallops Island, Va.
AGRO-ENVIRONMENTAL DEMONSTRATION AND TEST SYSTEM
J. Holland Scott 804-824-3411

The objective is to demonstrate the public benefit and cost effectiveness of an integrated system of hardware and software (Agro-Environmental Monitoring System) through issuance of computer generated crop management advisories to farmers in the State of Virginia; and to establish these crop management to the public. Utilizing the system, a series of tests and demonstrations of the effectiveness and utility of automated crop management advisories will be conducted. The Cecospora Leafspot Model has been selected as the initial demonstration project that will be managed by the automatic system and compared to uncontrolled acreage. Demonstration of precipitation and solar radiation models will also be conducted during this time period. Soil moisture determinations will be calculated from available data.

W80-70429 **644-10-02**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MULTISPECTRAL OBSERVATION OF POLLUTANTS SYSTEM
R. H. Green 213-354-6703

The objective of this task is to apply the capabilities developed in ultraviolet imaging on lunar and planetary missions in the development of an observational system which allows remote sensing of tropospheric pollutants over a large spatial region. This will allow synoptic visualization of trace atmospheric constituents such as sulfur dioxide, ozone, nitrogen dioxide, anthroprogenic aerosols and naturally occuring dusts. The application goals include industrial and power plant plume distributional studies (plume chases) and temporal assessment of the impact of new energy sources (such as coal gasification and liquefaction). The approach used includes the development of a multichannel UV imaging system (MOPS) with a minicomputer based data system which provides for calibration, decalibration, enhancement and display of real time imaging data. The operational arena includes both ground based and fixed wing aircraft measurement platforms. Potential users of the system will provide guidance in the evolution of the system. Plans are currently being developed with the Electrical Power Research Institute (EPRI) to apply MOPS in a program to assess the environmental impact of new installations for coal gasification and liquifaction.

W80-70430 **644-10-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SEAFLOOR REMOTE SENSING
J. R. Edberg 213-354-6123

The objectives are to apply the NASA/JPL developed computer image processing techniques to long range, synoptic side looking sonar images of the seafloor and to participate in the interpretation of these results. Images provided by the Institute of Oceanographic Sciences (England) will be computer processed to construct cartographically controlled mosaics, to improve visualization through enhancement, and create three-dimensional image displays of the seafloor. The processed images will be interpreted by IOS and JPL geologists to assess the value of the processing, to compare the results with images form NASA side looking radars, and to address specific topical research studies. The approach followed will be to digitize side looking sonar images provided by the IOS on analog tape, to process these images by geometric distortion removal, to enhance the images, and to construct mosaics. Depth data will be used to generate three-dimensional image displays of the seafloor. The results will be examined and interpreted using photogeological analyses synthesized with other oceanographic data, including seismic soundings and drill core results.

W80-70431 **644-10-04**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH ENERGY BENTHIC BOUNDARY LAYER EXPERIMENT (HEBBLE)
J. R. Edberg 213-354-6123

This effort would continue the HEBBLE planning effort, carried out during FY-79, into the system and subsystem design phases during FY-80. It would lead to subsystem fabrication and testing in FY-81, system assembly and testing in FY-82, and deployment of an array of ocean bottom landers in April 1983. Activities supporting a HEBBLE are currently underway at the Woods Hole Oceanographic Institution (WHOI), JPL and elsewhere, and are supported by the Office of Naval Research (ONR), the Department of Energy (DOE), and NASA. Information presently available has created such interest in the benthic boundary layer (BBL)--the region from a few tens of centimeters below the National Academy of Sciences has endorsed a continuing and more extensive program of BBL investigations, with Woods Hole to remain as the lead institution. The intent is to survey several possible deep ocean areas, and then to deploy a complex and integrated set of instruments at one or more selected sites on the ocean floor to obtain data for periods of up to six months. At Woods Hole's request, JPL, during FY-79, has assisted the HEBBLE science team in determining investigation needs, exploring alternative system design concepts, reconciling overall capabilities, priorities, and resources, and developing an overall program plan. The JPL activity has drawn heavily on experience gained from deep space exploration because the proposed ocean bottom landers are autonomous observation systems similar to the Laboratory's unmanned interplanetary spacecraft. A science working group has been formed by WHOI to develop scientific requirements and rationale for the program. It has interacted with a JPL system design team to develop system concepts in sufficient detail to make program cost estimates. The proposed FY-80, activity would begin executing the program plan developed during FY-79.

Advanced Communications Research

W80-70432 **650-20-16**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS SYSTEM ASSESSMENT STUDIES
J. J. Ward 216-433-4000

Communication System Assessment Studies are required to provide a continuing focus for NASA technology development. The objective of activities under this RTOP is to provide realistic assessments of the economic, technical and institutional feasibility of potential operational satellite communications systems. Key elements of these activities are: (1) the continual assessment of market demand for satellite communication services, (2) the conceptual definition of satellite system solutions to meet potential market demand, (3) the assessment of the cost/performance/institutional feasibility of satellite solutions when compared to alternatives, and (4) the identification of advanced technology required to implement viable satellite system concepts.

W80-70433 **650-20-18**
Marshall Space Flight Center, Huntsville, Ala.
SYSTEMS NETWORK ANALYSIS (GEOSTATIONARY PLATFORM)
W. T. Carey 205-453-3424
(643-10-01; 650-20-16; 650-60-18)

The objectives are: (1) to refine and update the mission and payload requirements for and concepts of potential operational Geostationary Platforms that were initially defined in the FY-78 and FY-79 OSTS and OSTA jointly funded studies; (2) to identify and define potential NASA experiment/demonstration platforms that would pave the way

for operational platforms; and (3) to develop substantiating programmatic (cost and schedule) data. Preliminary studies done by NASA, NASA contractors and independent industrial organizations over the past several years have pointed favorably toward the idea of using multidiscipline geostationary platforms as a more efficient and effective means of accommodating future communications and other missions in lieu of the traditional approach of flying numerous specialized satellites. Two such approaches/concepts are the orbital antenna farm (by COMSAT Labs and the switchboard in the sky) by NASA.

W80-70434 **650-60-18**
Lewis Research Center, Cleveland, Ohio.
30/20 GHz WIDEBAND TECHNOLOGY VERIFICATION SYSTEM DEFINITION
J. J. Ward 216-433-4000

The objective is to develop a requirements document identifying the general communication functions and system performance parameters for a 30/20 GHz experimental flight payload. This payload shall be configured to both adequately demonstrate the flight readiness of critical technology elements and allow the common carriers sufficient capability to verify the service applicability of future operational systems in the 30/20 GHz frequency band. The approach includes initially developing the general functional communications requirements of the experimental payload in concert with industry. Next, a series of space/ground segment configurations which respond to the functional requirements will be developed. For each configuration, critical technology elements will be identified and preliminary costs and implementation schedules defined. The range of configurations will then be narrowed through the process of Government/industry review, and the remaining candidate systems will be analyzed in detail at the sub system level to determine detailed system costs and implementation schedules. Finally, the general systems parameters of the candidate systems will be combined with the functional requirements to produce the requirements document for the C/D phase of the 30/20 GHz program.

W80-70435 **650-60-20**
Lewis Research Center, Cleveland, Ohio.
30/20 GHZ SPACECRAFT MULTIBEAM ANTENNA TECHNOLOGY
J. N. Sivo 216-433-6102

The purpose of this activity is to perform supporting research and technology development in the antennas, suitable for use in future communications satellites operating primarily in the 30/20 GHz band. This effort will develop analysis and synthesis techniques, conduct investigations, analyses, conceptual designs and evaluations of advanced spacecraft antenna systems that are capable of producing multibeam patterns for transmission of high power rf energy from geostationary satellites. The effort will determine the ranges of applicability of various design configurations as functions of rf performance and physical characteristics, e.g., volume, weight, and deployment techniques, and will select, design, fabricate, and test experimental models through proof-of-concept to evaluate the antenna hardware elements needed for approaches that will be appropriate for communications satellites in the mid 1980's. Investigations and analysis will be conducted on antenna types that will be capable of providing a number of individual fixed spot beams in addition to providing independent stearable beams. Physical characteristics being considered for the antenna system will permit packaging within the shuttle vehicle envelope.

W80-70436 **650-60-21**
Lewis Research Center, Cleveland, Ohio.
SATELLITE SWITCHING
J. N. Sivo 216-433-6102

The objective of this effort is to develop the switching technology for the routing of signals (traffic) aboard multibeam, multichannel 30/20 GHz communication satellites planned for the mid 1980's. The techniques to be explored include RF or IF switching, and baseband switching, both bit-stream processor types and full baseband processor types. To be included is the development of the switch matrix, the modulator/demodulators, and the control circuitry. The scope of this effort will cover (1) system analyses and syntheses of representative switching system architectures to identify the key issues in each, and to perform trade-off analyses to optimize channel utilization; and (2) the construction of proof-of-concept models to verify performance characteristics and fabrication techniques.

W80-70437 **650-60-22**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS SYSTEM COMPONENTS
J. N. Sivo 216-433-6102

The objectives are to (1) perform supporting research and technology development in the area of spacecraft transponders and transponder components including power amplifiers (tube and solid state), low noise amplifiers, and other transponder components indentified as needed in 30/20 GHz communications satellites system studies, and (2) to determine the ranges of applicability of various component design configurations as functions of performance requirements and physical characteristics, e.g., volume, weight, power. By means of principally a contractual program, analysis and synthesis techniques will be developed for the above satellite components; the developed techniques will be applied to determine the basic characteristics of components meeting specified requirements; experimental components will be fabricated; fabricated components will be tested and evaluated; and proof-of-concept tests will be performed in house on a brassboard transponder for a selected approach, using developed components, in late FY-82.

W80-70438 **650-60-23**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS SYSTEM BREADBOARD
J. N. Sivo 216-533-6102

The objective of this activity is to perform an operational evaluation of selected 30/20 GHz communications satellite transponder system concepts by the development of an inhouse breadboard model. The breadboard transponder will also be used for compatibility and performance testing of integrated experimental models of transponder components and subsystems developed for the 30/20 GHz communications program. The results of testing will aid in the development of requirements for the demonstration 30/20 GHz communications system. Using the results of two 30/20 GHz system definition studies and two 30/20 GHz service demand studies, a preliminary transponder circuit will be defined. Based on this circuit, off-the-shelf components, subsystems and instrumentation will be purchased to begin testing and familiarization with the circuit. A final transponder circuit design will then be selected through an evaluation of the results of the 30/20 Ghz Transponder Design Study under RTOP 650-60-18, and the results of an inhouse analysis of approaches to a 30/20 GHz demonstration system. Components and subsystems developed under RTOP 650-60-05 will be integrated into the final breadboard transponder circuit. Instrumentation necessary to evaluate the transponder circuit for its ability to process modulated signals will be purchased. System testing will then be conducted to define the characteristics of the transponder circuit.

Data Management

W80-70439 **656-31-02**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DATA BASE MANAGEMENT SYSTEMS PANEL
Nevin A. Bryant 213-354-7236

It is the purpose of this RTOP to enable JPL to continue to provide leadership for the NASA Data Base Management Systems (DBMS) Panel, including the preparation and distribution of reports of that group. The RTOP will also provide JPL data management representation to NASA's applications data service project. During FY-79 the RTOP has supported a workshop of DBMS panel members which began (1) identifying DBMS capabilities within NASA today, (2) establishing evaluation criteria and procedures to examine DBMS performance and effectiveness, and

(3) determining new technology areas needed to achieve OSTA objectives. Based upon the results of the DBMS panel findings, the RTOP will in FY-80 initiate support demonstrations of selected enabling technologies required for NASA's Applications Data Service and future OSTA missions. The areas of particular emphasis which may be addressed directly or in a support role will include central browse facility technology and human engineering requirements, archiving technology, DBMS standards, and non-NASA data bases inventory.

W80-70440 **656-33-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AUTOMATED MOSAICKING FOR GEOCODED DATA BASES
Nevin A. Bryant 213-354-7236

The major objectives of the tasks described include: (1) reducing the cost of performing digital geometric transformation and mosaicking, (2) developing transportable procedures for producing computer mosaics from digital frames of LANDSAT and other sensors processed by the GSFC master data processor, and (3) developing transportable general purpose mosaicking and geocoded data base interface software designed to provide multi-sensor and multitemporal registration of multiple scenes at minimal cost. Such procedures should permit LANDSAT digital data users to no longer be constrained by the framing convention used for LANDSAT and potentially achieve greater economies of scale in thematic mapping and enhanced image interpretation by extending their analysis over much larger areas. Moreover, they should facilitate the spatial integration of other satellite imaging systems having various pixel sizes, orbit declination, and image swath areas (e.g., HCMM, SEASAT SAR). Finally, the integration of previously developed software and procedures to register and compare image and graphical files will provide the means to automatically register non-NASA geocoded data bases with imaging data, thereby bringing NASA data into the mainstream of data processing at minimal cost. The current RTOP submittal surveys the work proposed under an Applications Notice submitted in June 1978 and approved in December 1978 by the Information Systems Branch of OSTA, and specifies the work to be undertaken in FY-80. The specific objectives of this proposed research are oriented toward the development of algorithms and associated software modules and systems integration to perimit an analyst to extend the MDP temporal registration and geometric correction to multiple-frame LANDSAT digital mosaics at standard map projections, achieve an automated geobase (e.g., nominal/ordinal) interface with the MDP output of LANDSAT digital images, and apply the software and procedures developed to three test cases. These would include ongoing research programs being undertaken by the image processing laboratory, thereby capitalizing on the current results for comparison with the developed technology.

W80-70441 **656-45-02**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
IMPROVED SPATIAL REGISTRATION OF RADAR AND OTHER IMAGING DATA
W. D. Stromberg 213-354-4228

By responding to different characteristics of the surface than conventional imagery, radar has broadened the diagnostic capability of remote sensing data. Hence the combined use in remote sensing applications of radar and other observational data as well as non-image geographically encoded data bases is becoming increasingly widespread. The required registration (i.e., achieving a precise geometric match) of radar with other image data or with nonimage data arranged in an image-like format is currently a laborious task. The objectives of the proposed effort are: (1) to develop procedures for improving registration accuracy, (2) to implement techniques which reduce the manual involvement in the registration process, and (3) to generate simplified registration algorithms potentially compatible with a broad range of image processing environments. The effort will proceed along two paths: development of algorithmic improvements (facilitation of tiepoint location and improvement of distortion modelling), and generation of operational efficiencies (introduction of greater feedback into manual procedures, extension of the level of automation, and production of low cost transportable techniques). It has been apparent from past investigations using multiple types of imagery that registration plays a key role in facilitating the manual interpretation of these data as well as making possible the application of computer techniques. The prolific radar imaging systems of the future (SEASAT, SIR-A, etc.), producing orders of magnitude more data than today's systems will generate a great demand for registration capabilities to produce more accurate and less costly products. The proposed effort is responsive to this need.

W80-70442 **656-62-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SYNTHETIC APERTURE RADAR (SAR) PROCESSOR
R. G. Piereson 213-354-3322
(506-20-25; 177-43-53)

The general objective is to develop high throughput synthetic aperture radar (SAR) data processor technology to meet the requirements of future space missions. This will be accomplished as follows: The interim digital processor will be upgraded by procuring a new computer and adding a hardware range correlator. This will allow more processing time and move the range compression function to hardware increasing the throughput by at least a factor of four. A developmental SAR processor will be designed and fabricated using available parts and technology. SEASAT and A/C data will be used in 1981 to demonstrate the high throughput capability of this processor. The development challenge lies with the system design and demonstration. Complete research will be conducted into advanced SAR processing techniques such as auto-focus to enhance the capability of SAR processors. In conjunction with industry, developmental work will be started that will lead to an advanced SAR processor utilizing the technology projected for the mid 1980's. This development will lead to an on board processor in the 1985 to 1990 time period.

Application Systems Verification Test

W80-70443 **658-20-02**
Marshall Space Flight Center, Huntsville, Ala.
APPLICATIONS SYSTEMS VERIFICATION AND TRANSFER PROGRAM
Dennis W. Camp 205-453-2087

The activity is directed toward an applications pilot test of a prototype system to provide satellite weather information to commercial aircraft operating in remote areas. The objective is to extend established technology by adaptive engineering to help meet the operational requirements and validate the benefits for the aviation community. The prototype system will be designed and assembled from commercially available hardware. It is not anticipated that any equipment development will be needed for this effort. All aspects of the proposed system will be closely coordinated with the aviation community, Federal Aviation Administration, and National Environmental Satellite Service/National Oceanic and Atmospheric Administration (NESS/NOAA). An interested commercial airline will be selected for the demonstration tests of the prototype system. The results of these tests will be made available to other potential users of this system.

Regional Application Transfer Activities

W80-70444 **663-03-00**
Langley Research Center, Hampton, Va.
REGIONAL APPLICATIONS - LANGLEY RESEARCH CENTER
W. D. Hypes 804-827-2486

The objective is to transfer NASA remote sensing technology to state and local governments in the Commonwealth of Virginia. The objective will be accomplished by providing technical liaison activity between potential users of the technology and the Regional Center at Goddard. The liaison activity includes participation in

the identification and definition of demonstration projects, assistance to the state in defining and implementing a state wide geographic information system containing a LANDSAT data base; and the offering of technical consultation to potential users who are not familiar with uses, limitations, and analysis techniques of remote sensor data.

Geodynamics

W80-70445 **676-10-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DATA REDUCTION AND EPHEMERIS CALCULATION
C. B. Solloway 213-354-4888
(681-05-02; 161-22-01)

This RTOP describes the prediction of lunar laser range observations, lunar ephemeris and physical model improvement, and data analysis activities within the Lunar Laser Ranging Experiment. It has four major objectives: (1) to continue to support the observing programs at the McDonald, Haleakala, and Orroral Valley Observatories with high precision range predictions; (predictions will be started for the Wetzell site); (2) to analyze the lunar laser ranges by least squares techniques to determine observatory locations, earth rotation and nutation, the lunar orbit and physical librations, and various other geophysical and astronomical parameters; (3) to perform numerical integrations of the lunar physical librations and orbit and to continue to improve the physical modeling of the ranges in order to get the high accuracy needed to analyze the range data; and (4) to generate UTO values for earth rotation studies and to use multiple observatory data for earth rotation and baseline studies. This effort will satisfy the need for an accurate physical model of the lunar laser ranges which will contribute towards understanding the rotational motions of the earth and moon and achieving precision geodesy at intercontinental distances.

W80-70446 **676-10-10**
Goddard Space Flight Center, Greenbelt, Md.
REGIONAL CRUSTAL DEFORMATION MODELING
G. D. Mead 301-344-8470
(677-45-01)

The objective is to conduct modeling studies of crustal deformation relevant to the analysis and geophysical interpretation of geodetic data obtained under NASA's Crustal Dynamics Project. The approach will be to develop models to earthquake mechanisms, fault motions and regional tectonics in active seismic areas; and relate these models to deformations which might be observable using space techniques. Specific areas of study include the San Andreas and Elsinore fault regions in California, the southeastern United States, and active tectonic regions of the Caribbean and South America. Models of solid-earth tides and ocean loading will be developed and related to VLBI and laser measurements of crustal deformation.

W80-70447 **676-10-11**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CRUSTAL DYNAMICS INFORMATION MANAGEMENT NETWORK
C. B. Solloway 213-354-4888

The purpose of this RTOP is to define requirements and to develop and evaluate concepts for a NASA crustal dynamics information network. This network will provide investigators access in a timely manner to information which integrates astronomically and conventionally-derived geodetic as well as related geophysical data such as gravity, seismicity, tilt, strain, and other data types. To meet this objective, the FY-80 activity will continue the development of a Crustal Dynamics Information Management Network, based upon results of the feasibility study done in FY-79, by performing three major tasks. The first of these tasks will refine the user requirements for this system to more clearly identify user groups, their characteristics and the existing flow of data among them. The second task will determine an optimal top-level system architecture, based upon the identification and evaluation of design alternatives, for major system parameters such as existing networks versus new facilities, storage technologies, standardization, and access mechanisms. The final task will develop detailed functional requirements that satisfy the user requirements and the concepts emerging from the tradeoff analysis. Interfaces will be maintained with the Applications Data Service and The Crustal Dynamics Projects, in order to ensure the compatibility of the CDIMN with systems implemented or planned by those projects.

W80-70448 **676-30-01**
Goddard Space Flight Center, Greenbelt, Md.
GLOBAL EARTH STRUCTURE AND DYNAMICS
D. E. Smith 301-344-8555

The objectives are to improve our understanding and knowledge of the dynamics of the earth by the development of models of polar motion and earth rotation, global plate motion, mantle convection, plate driving mechanisms, the dynamics of the core, and earth tides; and to improve our knowledge and understanding of the global structure of the earth, its interior properties, its crustal magnetization, the gravity field and its anomalies, and the evolution of the lithosphere and crust. Theoretical and numerical studies will be conducted of the density structure, stress and rheology of the mantle and lithosphere based on gravity, altimetry, tracking and supporting geophysical data. The high frequency terms in the rotation of the earth will be investigated near one and two cycles per day using satellite tracking of Lageos and other spacecraft, together with studies of the tidal perturbations of satellites for the estimation of tidal amplitudes and phases. The RTOP addresses the following major problems: (1) the understanding of the processes and mechanisms of plate motion and mantle convection, (2) the properties and evolution of the lithosphere, (3)the deformation of the earth by tidal forces, and (4) the rotation of the earth near the diurnal and semi-diurnal frequencies.

W80-70449 **676-40-01**
Goddard Space Flight Center, Greenbelt, Md.
GEOPOTENTIAL FIELDS
D. E. Smith 301-344-8555

The objectives of this RTOP are the development of gravity and magnetic field models and associated analytical methods, data analysis techniques and supporting software systems. From the analysis of satellite tracking data, in conjunction with satellite altimetry and surface measurement data, models of the earth's gravitational field, shape and size will be derived. Altimetry data over the oceans will be used to derive the geometric sea surface. Alternate methods of representation of the magnetic field will be investigated that will accurately represent the nonlinear variations. Spectral characteristics of the magnetic anomaly and external fields will be studied and cross-correlation techniques applied to the data to isolate the time-invariant field from the crust. This RTOP supports the following program areas: (1) the development of models of the earth's interior structure, (2) the development of lithospheric models, (3) the determination of the ocean geoid for oceanography, (4) the investigation of core motions and dynamics, and (5) the use of magnetic and gravity data for resource assessment.

W80-70450 **676-50-01**
Marshall Space Flight Center, Huntsville, Ala.
EARTHQUAKE HAZARDS REDUCTION PROGRAM, REQUIREMENTS DEFINITION AND ANALYSIS
N. C. Costes 205-453-0946
(750-01-59)

The objectives are to identify, define, and analyze requirements for earthquake hazards reduction research which can be accommodated with NASA facilities and capabilities; and develope a NASA earthquake engineering research project plan, consistent with requirements from earthquake engineering community, The National Science Foundation and other federal agencies. The approach will be to maintain liaison with earthquake engineering community through workshops, conference etc., to identify, define and analyze earthquake engineering research requirements which can be accommodated with NASA facilities and capabilities; during FY-80, focus on planning for initial classes of experiments recommended by earthquake engineering specialists, during

NASA/NSF workshop held at MSFC, which do not require MSFC facility modifications; and update preliminary NASA Earthquake Engineering Research Project Plan, developed in FY-79.

W80-70451 676-59-30
Marshall Space Flight Center, Huntsville, Ala.
SUPERCONDUCTING GRAVITY GRADIOMETER
E. W. Urban 205-453-5132

The objectives of this activity are to investigate and demonstrate the application of a cryogenic system to improve the sensitivity and enhance the dimensional stability of a gravity gradiometer with very small hysteresis and creep for an orbiting satellite. Such an instrument will be used for improved geological and navigational applications. To attain the objectives of this effort, the program will be conducted in two phases. The first phase will be to fabricate and test a prototype single axis gravity gradiometer which will operate at liquid helium temperature. The following phase will involve the use of the techniques developed in the single axis gravity gradiometer to construct and demonstrate a working three axis magnetometer. The activity will be based on a concept proposed by the Department of Physics and Astronomy (Drs. Paik and Richard) of the University of Maryland.

W80-70452 676-59-30
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SATELLITE EMISSION RADIO INTERFEROMETRIC EARTH SURVEYING (SERIES)
C. B. Solloway 213-354-4888
(161-22-01)

The objectives are to conduct studies and demonstrations of the feasibility of using the Global Positioning System satellite radio emissions in a radio interferometric manner to achieve a geodetic system capable of subdecimeter baseline vector accuracy. The specific issues in need of investigation are verification of SERIES telecommunications performance modelling and ionospheric calibration by dual L-band observations, and assess the probable cost drivers for a future operational SERIES system and particularly estimate the element of a water vapor radiometer included into each session. The approach will be to implement a pair of SERIES proof-of-concept stations and data processing software to measure the baseline vector between two known locations with a precision of 10 cm or better. Because a total of five SERIES stations would have to be available to be satellite ephemeris independent, the initial experiments using a single pair of stations will use the satellite ephermerides provided through Department of Defense cooperation to derive the baseline vector from SERIES system delay observations. The need for tropospheric water vapor calibration will be studied in the context of anticipated rapid SERIES system deployment options and probable frequent-move routine operations. Because water vapor radiometry is now a proven technology of considerable flexibility and accuracy, the use of WVR calibrations to SERIES data will be analyzed to provide a set of functional requirements on future industrially procured WVR instruments.

W80-70453 676-59-30
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED STUDIES AND CONCEPTS
W. D. Kahn 301-344-8554
(677-59-10)

The objectives are to conduct studies related to the development of advanced sensor, ground system, and space missions concepts in terms of improved accuracy, mobility, and operational effectiveness; and study the feasibility of unifying geophysical phenomena into a comprehensive dynamic model of the earth. A series of studies will be undertaken to determine how continuous laser range measurements provided by a constellation of Lageos satellites can improve operational efficiency of transportable laser ranging systems and define the broad range of geodynamic parameters which can be determined from the measurements. Studies will also be performed to assess the feasibility of specifying a comprehensive dynamic model of the earth. The RTOP supports the following major programs: (1) earth dynamics, (2) earth structure, and (3) crustal hazards. These in turn, support the following 'end' objectives: improved understanding of the relationship of plate motions and earthquakes, the accumulation of strain over seismically active regions, and global geodesy.

Resource Observations Applied Research and Data Analysis

W80-70454 677-21-03
Goddard Space Flight Center, Greenbelt, Md.
URBAN AREA DELINEATION BY REMOTE SENSING
David L. Toll 301-344-7122
(677-21-08; 677-21-10)

The objectives are: (1) to develop, evaluate, and demonstrate remote sensing techniques using spectral, spatial, and temporal information as applied to improving the detection of urban parameters in a joint NASA/Bureau of the Census study; (2) test future and current sensor parameters for applicability in the urban fringe zone; (3) evaluate procedures and usefulness of incorporating ancillary information with satellite information; and (4) evaluate applicability of using remotely sensed change data to predict urban expansion. Sensor/system parameters will be evaluated for urban area applications. Ancillary data planes will be tested for their contribution to improve urban classification. Surface texture information will be tested for improving urban classification. Remotely sensed change information will be evaluated for use in predicting urban growth.

W80-70455 677-21-04
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE USE OF SYNTHETIC APERTURE RADAR DATA FOR THE STUDY OF URBAN MORPHOLOGY
M. L. Bryan 213-354-2739

The objectives of the urban morphology program are: (1) to combine LANDSAT data with L-band data obtained from aircraft and satellite (Seasat-A) of urban area; (2) to determine the accuracy of interpretation of urban land cover from these combined data sets; (3) to determine the degree to which SAR and LANDSAT data supplement and complement one another with respect to the preparation of urban land cover maps; and (4) to identify the transference of radar interpretation techniques developed with airborne systems to those SAR data obtained from satellite borne radars (Seasat-A, SIR-A). This study will use both airborne and spaceborne (Seasat-A, SIR-A) L-band data. X-band data from aircraft are also to be used. The several sets of radar data will be, selectively, digitized and prepared for use in a computer. The data will be registered with LANDSAT data and to a known map projection. The effect of the addition of the radar data to the LANDSAT data and computer algorithms used for LANDSAT will be studied, with respect to the accuracy of the land use classifications. Selected sets of radar data will be processed at different resolutions and registered to the LANDSAT data. Computer algorithms previously used will be employed to determine the effect of decreased resolution on the accuracy of automatic mapping of urban land cover. Individuals will manually interpret the radar data which have been processed at different resolutions and speckle to identify the effect of these two parameters on the accuracy of interpretations.

W80-70456 677-21-05
National Space Technology Labs., Bay Saint Louis, Miss.
IMPROVED TECHNIQUES/LAND COVER
A. T. Joyce 601-494-3830

The overall objective is to develop, test, and evaluate new techniques and improved software to increase the accuracy and precision of aerial measurement, identification, classification, and mapping of vegetation/land cover types. The same test site will be used for all testing and evaluation so that the improvements can be quantified and compared with existing techniques. Techniques to be tested and evaluated during FY-80 include (1) derivation of spatial parameter, (2) use of point cluster in automated signature development, (3) multitemporal classification, and (4) principle component analysis. As evaluated techniques are proven to be better than existing techniques, they will be

adequately documented to permit successful transfer to other centers and, through COSMIC, to the user community at large.

W80-70457 **677-21-06**
National Space Technology Labs., Bay Saint Louis, Miss.
INTEGRATION OF VIS-IR-MW DATA
S. T. Wu 601-688-3830

The basic objective is to evaluate the results of combined data acquired with multispectral scanners and synthetic aperature imaging radars and processed to derive land resource inventory information. The technical approach will be as follows: (1) derive land resources information from MSS digital data acquired by LANDSAT 3; (2) derive land resources information from synthetic aperature radar digital data acquired by Seasat and aircraft APQ-102A over the same test sites for which LANDSAT data was processed; (3) develop MSS & SAR data overlay technique to merge the two sets; (4) derive land resources information from a digital data set produced by merging the Seasat or aircraft SAR and LANDSAT MSS data used for (1) and (2); and (5) evaluate the results with respect to the number, types, and accuracy of land cover/vegetation classes derived by processing Seasat or aircraft SAR and LANDSAT MSS data independently, and compare these results with those produced from processing the merged SAR-MSS digital data sets. Test sites will be located on the Mississippi-Louisiana coastal plains.

W80-70458 **677-21-07**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INFORMATION SYSTEMS INTERFACES FOR IMPROVED LAND RESOURCES CLASSIFICATION
Nevin A. Bryant 213-354-7236

It is the purpose of this task to improve the efficiency of land resource classification and mapping by providing a generalized capability to merge and manipulate diverse sets of environmental data (including satellite image-derived data) within an information systems context, and developing efficient systems software to directly input thematically classified digital data into existing geo-coded data base systems. To accomplish the stated objectives four areas of systems software need to be pursued in parallel during the next three years. Efficient raster-to-graphics conversion software designed to transform thematically classified imagery files to arc segment and double digitized boundary graphics vector files will be developed. This would complement the existing capabilities of graphics-to-raster and image-to-map projection conversion and assure a convertability of satellite data to the format used by principal U.S. geo-coded data bases such as the USGS Land Use Data Analysis Program and the U.S. Census DIME and Urban Atlas Files. Software and procedures will be improved to make digital terrain data compatable with NASA imagery sensor data. Standard NCIC digital terrain data derived from 1:250,000 and 1:24,000 map series will be interfaced and a sensitivity analysis of elevation, and derived slope gradient and slope aspect files will be reported. Software that uses digital terrain files to perform a pixel-by-pixel geometric transformation to correct MSS scanner and imaging SAR horizontal displacement errors caused by topographic relief will be developed and studies conducted to determine the potential problems inherent in registering LANDSAT MSS data (both from prior LANDSAT and resident on LANDSAT D) with TM data. Each of the four development areas will involve three stages: first, conduct studies under subcontract academic institutions and JPL on existing interface procedures and software efficiencies; second, implement recommended algorithm(s) in VICAR at JPL; and third, exercise the developed software on selected test cases at JPL and selected university research laboratories and document the findings.

W80-70459 **677-21-08**
Lyndon B. Johnson Space Center, Houston, Tex.
EVALUATION AND IMPROVEMENT OF CHANGE DETECTION PROCESSES FOR LAND RESOURCES PARAMETERS FROM REMOTELY SENSED DATA
F. Ravet 713-483-4505

The basic objective is to develop a clear understanding of the concepts associated with change detection requirements, and to formulate a strategy and define a capability for Landsat-based remote sensing analysis technology to satisfy these requirements. A problem statement which can describe this objective is 'In what manner can Landsat data analysis be used as an aid to the understanding and quantification of changes in land resources parameters?' To accomplish this objective, an assessment of the requirements for change detection information will be performed, and Landsat data analysis capabilities will be evaluated in a manner which correlates directly with the requirements. A thorough assessment of change information needs will be accomplished through literature review, research, and direct contact with prospective users. The needs will be categorized in a manner that relates directly to the technological requirements necessary to produce the information. Landsat data characteristics will be thoroughly evaluated and tested under consistent conditions to assess the theoretical and practical capabilities of the system to produce different types of change information. This will be carefully matched with the information requirements, and then ranked according to approximate cost and benefit guidelines.

W80-70460 **677-21-08**
National Space Technology Labs., Bay Saint Louis, Miss.
EVALUATION AND IMPROVEMENT OF LAND RESOURCES CHANGE DETECTION PROCEDURES
A. T. Joyce 601-688-3830

The objective is to improve the capability to detect changes in land resources through the analysis of remotely sensed data in a variety of environments for both specific and general thematic classes of land resources parameters. The approach will be as follows: (1) analyze the processes and characteristics of several types of land use change; (2) relate the processes and characteristics of LANDSAT MSS and TM sensor system parameters, and perform tests and evaluations for land use change conditions that are compatible with the sensors; and (3) determine sensor system requirements needed to attain 90% + or - 5% change detection accuracy for any land use change conditions for which that accuracy cannot be attained with LANDSAT MSS and TM data. The LANDSAT MSS and TM data processing techniques that are successful will be documented for transfer to other NASA centers, and, through COSMIC, to the user community at large.

W80-70461 **677-21-08**
Ames Research Center, Moffett Field, Calif.
EVALUATION AND IMPROVEMENT OF CHANGE DETECTION PROCEDURES
H. W. Jones 415-965-6440
(677-21-02; 677-21-11)

The objective is to improve the capability to detect changes in land resources through the analysis of multidate multistage remotely sensed data in a variety of environments for both specific and general thematic classes of land resource parameters. The approach is to: (1) develop software and data analysis procedures to detect changes in various land resource parameters using the multitemporal decision tree classifier as well as image differencing, classification differencing, and principal components differencing, and to evaluate these approaches to thematic classification in a number of geographic locations with diverse terrain and environmental conditions; (2) construct regional change detection calendars; (3) identify the most effective timing of image acquisition to detect changes in various landscape parameters; and (4) evaluate the potential of detecting changes using multisensor, multiplatform data. Most of the work will be performed by university contract.

W80-70462 **677-21-08**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
IMPROVED CHANGE DETECTION PROCEDURES FOR ANALYSIS AND MONITORING OF LAND RESOURCES
S. Z. Friedman 213-354-5113
(677-21-03; 677-21-09)

The objective of this research will be the development of improved change detection procedures for monitoring changes in aerial extents of land resources through analysis of satellite and colateral data. The primary focus will be determining most effective change detection procedures for mapping changes in first order land cover classes defined by the USGS. Federal,

state, and local government agencies would directly benefit from the results of such research. Change detection procedures to be investigated will include both spectral and spatial data processing schemes to determine characteristic spectral signatures, patterns, and textures of change areas. By combining the results of these approaches, the transformation of incoming data into a useful change detection information base will become possible. Facilities at the Image Processing Laboratory of JPL will be utilized. Software developed for imaging associated with unmanned space missions and Earth resources applications will be utilized and extended to provide a capability for detecting changes in land resources distributions. An information system will be utilized to facilitate the combination of multistage data and the formation of comprehensive data bases. During FY-80, procedures will be tested to determine optimal techniques for detecting changes in first order land resources. Emphasis will be placed initially on urban changes, followed by detecting changes in agricultural, range, and forest resources. Also a review of previous change detection research will be completed. In FY-81, colateral data (e.g., DMA topographic data, census data, thematic maps) will be included in research to facilitate interpretation and analysis. User agencies (e.g., USGS, USFS, Census Bureau) will be consulted to define specific parameters for a change detection system. For FY-82, change detection information will be combined, with other geographic data to produce regional change detection calendars. Recommendations will be made regarding strategy for future Earth Resources Applications missions including image acquisition scenarios and image sensor functional characteristics to optimize change detection analysis. Research will culminate with the formation of a basic design for a change detection system.

W80-70463 **677-21-08**
Goddard Space Flight Center, Greenbelt, Md.
EVALUATION AND IMPROVEMENT OF CHANGE DETECTION PROCEDURES FOR LAND RESOURCES PARAMETERS FROM REMOTELY SENSED DATA
D. L. Toll 301-344-7122
(677-21-03; 677-21-10; 677-21-12)

The objective is to improve our capability of detecting land use/land cover change for land resource surveys through the use of remotely sensed data in a variety of environments. The approach is: (1) to evaluate and further develop change detection techniques, drawing upon change detection work being conducted currently by NASA agencies; (2) evaluate satellite data preprocessing functions (e.g., atmospheric, sun angle, and geometric corrections) for improving classification accuracy of change areas; (3) assesses the usefulness of incorporating ancillary data to improve the classification of change categories; (4) investigates applicability of multistage sampling techniques for obtaining more detailed land cover information; and (5) evaluates both the techniques and the usefulness of incorporating satellite derived change data and ancillary data into a model to predict urban change.

W80-70464 **677-21-09**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LAND RESOURCE MODELLING
Nevin A. Bryant 213-354-7236

It is the purpose of this task to advance the state-of-the-art of resource management analyses and planning activities undertaken by government agencies and private consulting firms by developing software and procedures that integrate remotely sensed data and collateral data with models to predict change and assess the capability/suitability of land resources in a region. It is expected that change prediction and capability/suitability modelling that incorporates Landsat derived data will help NASA focus upon the more pertinent parameters for geometric and classification accuracy on future missions and associated SRT areas in land resources. Improvements in our capability to integrate remotely sensed data into land resources modelling will be pursued by developing software and procedures for predicting land use change. One predictive modelling subtask is to be based on the concepts of a priori and a posteriori information. A second subtask will incorporate a time series of Landsat scenes which have detected change. A third subtask will incorporate the concept of cellular transformations/continguity effects to predict change, and developing procedures and software which integrate remotely sensed data with other collateral data and ancillary socioeconomic/environmental data sources into models which assess and/or predict potential land capability or productivity under varying constraints to land use. Both modelling areas will involve three stages: (1) conducting studies at subcontracted academic institutions, private consulting firms engaged in land resource assessment, and JPL on existing models most likely to benefit from the integration of remotely sensed data; (2) implementing recommended algorithm(s) and procedures in VICAR at JPL; and (3) exercise the developed software on selected test cases at JPL and selected university research laboratories and document the findings.

W80-70465 **677-21-10**
Lyndon B. Johnson Space Center, Houston, Tex.
LAND RESOURCES SENSOR EVALUATION
Ben R. Hand 713-483-3155
(667-36-05)

The objective is to determine the usefulness of airborne and spacecraft-borne visible and infrared (VIS-IR) sensors in acquiring land cover information so that the optimum design for a future spacecraft-borne VIS-IR system can be specified. Issues related to sensor performance parameters as required for land resource applications will be resolved. Performance parameters of current airborne and spaceborne sensors will be used to predict technical capabilities and hardware state-of-the-art of future sensors. Land resource application requirements in terms of spatial resolution, spectral bands (placement and width), radiometric sensitivity, time-of-day, repeat cycles, and sampling techniques including offset pointing will be assessed and sensor system performance capabilities evaluated.

W80-70466 **677-21-10**
National Space Technology Labs., Bay Saint Louis, Miss.
LAND RESOURCES SENSOR EVALUATION
J. E. Anderson 601-688-3830

The objective is to provide information pertinent to the design of future land resource oriented sensors with respect to the manner that the spatial and spectral characteristics of the sensor and the time of data acquisition affects the identification and classification accuracy of forest versus nonforest, forest densities (crown closure), and forest species type as part of a general land cover inventory. Data acquired with the LANDSAT MSS, LANDSAT TM, and aircraft-mounted NS001 will be utilized to address IFOV's of 79, 30, 15, and 5 meters. Particular emphasis will be placed on arriving at early conclusions pertinent to the spatial resolution proposed for the Multispectral Resources Sampler.

W80-70467 **677-21-10**
Goddard Space Flight Center, Greenbelt, Md.
LAND RESOURCES SENSOR EVALUATION
B. L. Markham 301-344-5240
(677-21-03)

The objective is to provide input to the design of future land resources oriented satellite sensors and systems (beyond Landsat-D) in terms of the: (1) spatial and radiometric resolutions; (2) spectral bands and bandwidths; and (3) acquisition time and frequency required to identify various land resources targets. The spectral, spatial and temporal characteristics of selected land resources targets in various geographical regions will be examined through a preliminary literature review, followed by analysis of existing and/or newly acquired remotely sensed data and corresponding ground data sets. The selection of targets and target characteristics to be evaluated will be based in part on the research needs evident from the recent user needs/design requirements studies, e.g., operational earth resources satellite and integrated remote sensing system study.

W80-70468 **677-21-11**
Ames Research Center, Moffett Field, Calif.
ACCURACY ASSESSMENT OF SATELLITE DERIVED LAND-USE MAP
H. W. Jones 415-965-6440
(677-21-10)

The objectives are to develop the test methodologies for assessing the accuracy of land use maps produced from LANDSAT and other satellite digital data, and to investigate methods of using results of accuracy evaluations to improve classification performance in an iterative classification process. The approach to these objectives includes five efforts: (1) to examine how the relationship between the minimum mapping units achieved through photointerpretation and LANDSAT classification affect accuracy assessment; (2) implement a version of the sampling methodology used by the U.S. Geological Survey to assess the accuracy of their polygon format land use maps; (3) investigate the kinds of errors made, to determine quantitatively the classes that LANDSAT maps well or poorly; (4) determine appropriate methods of quantifying accuracy and communicating results to the user; and (5) investigate methods of using accuracy assessment in an iterative process to improve classification results.

W80-70469 **677-21-12**
Lyndon B. Johnson Space Center, Houston, Tex.
REMOTE SENSING LAND RESOURCE DATA BASE INFORMATION INTEGRATION
John C. Lyon 713-483-5528

The objective of this task is to research and develop common solutions to unresolved technical issues in integrating and managing remote sensing, geographic, and other data sources used in environmental modeling, classification, and other applications. The issues in selected land resource topics will be surveyed and those which are unresolved will be researched. It is expected that many such problems are the results of the user's lack of knowledge of existing geographic and data management capabilities and his lack of expertise in this discipline. The user may not discover his need for data management until he is well into his experiments. He may also encounter some technical issues which have not been resolved by the general community. To aid the user in the effective use of his data, user problems will be documented for selected land resource topics. Existing capabilities will be surveyed and problems which have not been resolved will be researched. Prototype solutions common to most land resources users and applications will be developed and tested to measure their effectiveness for specific modeling applications. A user's guide will then be developed to provide the user with a road map for developing his own data management capability. This guide will attempt to define state-of-the-art, specify capabilities required for specific applications, and document the sources for such capabilities.

W80-70470 **677-21-12**
Lyndon B. Johnson Space Center, Houston, Tex.
REMOTE SENSING LAND RESOURCE DATA BASE INFORMATION INTEGRATION
Robert L. Rowley 713-483-4505

The objective of this task is to research and develop solutions to unresolved technical issues in integrating and managing remote sensing, geographic, and other data sources used in environmental modeling, classification, and other applications. The issues in selected land resource topics will be surveyed and those which are unresolved will be researched. It is expected that many such problems are the result of the user's lack of knowledge of existing geographic and data management capabilities and his lack of expertise in this discipline. The user may not discover his need for data management until he is well into his experiment. He may also encounter some technical issues which have not been resolved by the general community. To aid the user in the effective use of his data, user problems will be documented for selected land resource topics. Existing capabilities will be surveyed and problems which have not been resolved will be researched. Prototype solutions will be developed and tested to measure their effectiveness for specific modeling applications. A user's guide will then be developed to provide the user with a road map for developing his own data management capability. This guide will attempt to define terms of art, specify capabilities required for specific applications, and document the sources for such capabilities.

W80-70471 **677-21-12**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING LAND RESOURCES DATA BASE INFORMATION INTEGRATION
J. R. Irons 301-344-5240
(677-21-03)

The primary objective is to assess the utility of integrating satellite remotely sensed data with other land resource information in automated, geographically referenced data bases for more effective land resource investigations. This objective requires developing efficient data integration techniques, utilizing integrated data for resource mapping, analysis, and modeling, and evaluating the accuracy of the maps and models. The research will be conducted within the contex of a significant land resource problem:. the impact of urban expansion on agricultural land and production capabilities. The following tasks will be addressed: (1) select a test site in a rapidly expanding urban area and encode an automated data base of spatial resource information; (2) process LANDSAT MSS data to delineate land cover and monitor urban expansion; (3) develop software to automatically integrate LANDSAT data into the data base; (4) use the integrated data base to derive analytical information and generate interpretive maps to assess agricultural land quality and the impact of urbanization; (5) develop a model to predict future when expansion on agricultural land; and (6) investigate the incorporation of data from future sensors into the data base.

W80-70472 **677-21-12**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
REMOTE SENSING LAND RESOURCE DATA BASE INFORMATION INTEGRATION
R. J. Blackwell 213-354-5677
(667-21-07; 677-21-09)

The objective of this task is to demonstrate that remote sensing data can be integrated with other types of land resource information and data to aid in the development of mathematical models of land resource environmental parameters. Remote sensing data provides a means of augmenting inputs to land capability models and further provides a means of accounting for the temporal nature of land use and land cover. These derived data, in addition to other existing information such as: topographic data, soils type, geology, meteorological data, drainage basin location and extent as well as other in-situ data provides for an integrated data base. This data base in turn can be used to great advantage to derive inputs to land capability models. A test area has been selected which will permit an assessment of the usefulness of remote sensing data as applied to land resource data base information integration. Lake Tahoe, California represents a unique drainage basin configuration. It is an isolated ecosystem which is currently under considerable urban stress. An abundance of historical environmental and land resource data exists and is available. There are a number of national, state and local-level agencies concerned about the welfare of the lake and are committed to environmental protection. The FY-80 activity would assemble a comprehensive land resource inventory and environmental data base. Relationships with the Tahoe Regional Planning Agency, USDA Forest Service, soil conservation service will be further developed. Discussions are planned with the developer of the existing Lake Tahoe capability and suitability maps, Dr. Robert G. Bailey, to solicit his participation in the project. Future fiscal years would involve the generation of additional integrated data bases for information processing and modelling applications, sites to be selected in conjunction with cooperating user agencies requirements.

W80-70473 **677-22-02**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED MICROWAVE SOIL MOISTURE STUDIES
T. J. Schmugge 301-344-6059
(677-22-08; 677-22-13; 677-22-06)

The objectives are to extend our knowledge on the use of microwave radiometers for soil moisture sensing to longer

wavelengths and long term repetitive flight coverage. The specific goals are: (1) quantify the improvement that would be afforded by using a longer wavelength (49 cm); (2) determine if multiple wavelength (21 and 49 cm) observations can yield information on the near surface soil moisture gradient; and (3) determine if subsurface hydrologic features and spatial variation of rainfall can be observed with repetitive observations. The approach will be as follows: field measurements using radiometers at 6, 21 and 49 cm wavelengths mounted on a mobile tower will be conducted on both bare and vegetated fields; set of 10 flights during a 30-day period is planned over an area which has a near surface water table to study the use of the temporal variations of the microwave response; and analysis and modeling efforts to bring together the results of these two measurements activities into a consistent picture.

W80-70474 **677-22-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOIL MOISTURE DETERMINATION USING MICROWAVE/ INFRARED TECHNIQUES
E. G. Njoku 213-354-7748

Microwave radiometry has been proved a useful remote sensing tool for Earth observations by a series of experiments on Nimbus 5, Nimbus 6 and Skylab. These have led to other microwave experiments on Nimbus 7 and Seasat, and proposed for the Space Shuttle. Multifrequency measurements with improved resolution and at longer wavelengths are especially useful for observing phenomena such as soil moisture. The High Resolution Imaging Microwave Radiometers, being proposed for launch in the Shuttle era would provide such measurements and would include an infrared radiometer to resolve the ambiquity caused by variations in the Earth surface temperature. This task will provide the supporting research required for interpreting multifrequency, multipolarization microwave data, and thermal infrared data, in terms of soil moisture parameters of interest for agriculture, climate, and hydrology applications. The research will include theoretical modeling to take into account moisture and temperature profiles in the soil, surface roughness effects, soil type variations, and the combined information content of microwave and infrared data. In addition, an experimental study will be made of the relationships between moisture and temperature profiles as functions of soil type and micrometeorological variables at the air-soil interface. This will be combined with truck-based microwave radiometric radiometric measurements to provide a data set for the modeling effort. Such an approach will lead to improved algorithms for the determination of soil moisture parameters. Present JPL instrumentation to be used in the experimental study includes a van mounted microwave radiometry system with frequencies of 0.6 to 0.9, 1.42 and 10.69 GHz, and a micrometeorological vertical profile array to monitor meteorological conditions at or near the surface.

W80-70475 **677-22-06**
Goddard Space Flight Center, Greenbelt, Md.
INFORMATION CONTENT STUDIES WITH MICROWAVE AND THERMAL IR DATA
A. Rango 301-344-5480
(677-22-07; 677-22-08; 677-22-11; 677-22-19)

The objectives are: (1) determine the capabilities of microwave sensors for measuring significant snowpack parameters useful in snowmelt runoff prediction; (2) determine microwave capabilities for supplying soil moisture data for operational agency needs, for watershed characterization, and for use from space platforms; (3) investigate microwave potential for detecting freeze-thaw lines, ice condition, and surface water area; and (4) evaluate advanced thermal and Landsat data for water resources management. The microwave signature of the snowpack will be related to hydrologic properties via field experiments and A/C overflights. Microwave A/C flights over USDA/SEA/AR watersheds plus Seasat SAR data will be analyzed in cooperation with SEA personnel. A comparison of seasonal A/C overflights in Alaska will be used to differentiate between varying hydrologic conditions. Landsat C and thematic manner simulator data will be acquired and analyzed over existing visible and near IR study sites.

W80-70476 **677-22-07**
Goddard Space Flight Center, Greenbelt, Md.
HYDROLOGIC MODELING STUDIES
J. Ormsby 301-344-6507
(677-22-06)

The objective of this research is to ascertain the incremental improvements resulting from advanced remote sensing data systems for monitoring soil wetness, snowpack properties, freeze/thaw boundaries, runoff coefficients, impervious areas, and evapotranspiration when applied to various models of watersheds and environmental systems. In addition to the information content research on remotely sensed data, these data will be used as input to existing or modified water balance, energy budget and runoff prediction models. Sensitivity tests and analyses of existing models will be undertaken to ascertain requirements for future spacecraft systems.

W80-70477 **677-22-08**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING OF SOIL MOISTURE FOR WATER RESOURCES
T. J. Schmugge 301-344-6059
(677-22-06; 677-22-07)

The possibility of detecting soil moisture variations with microwave and IR techniques has been demonstrated. The need now is for quantification of the limitations of these techniques so that the usefulness of these approaches can be assessed more accurately. Therefore, the objectives of this research are to continue the evaluation on the use of microwave, both active and passive, and thermal IR techniques for the remote sensing of soil moisture for use in water resources; and to acquire the data and perform the analysis of these data to satisfy the bilateral agreement with the USSR on the study of soil moisture sensing with microwave radiometers. Analysis of data acquired during aircraft flights and from existing spacecraft will be the primary approach. This will be supplemented by radiative transfer modeling efforts to estimate microwave brightness temperatures for realistic moisture and temperature profiles under various surface conditions. A comparison of the modeling efforts with aircraft and satellite measurements will be performed.

W80-70478 **677-22-10**
Goddard Space Flight Center, Greenbelt, Md.
GROUND BASED PASSIVE MICROWAVE (MOBILE) FIELD TEST FACILITY
James C. Shiue 201-344-6716
(677-22-06; 677-22-22; 677-11-01; 677-22-08)

The objective of this research is to build a ground based passive microwave mobile field test facility for conducting experiments to study microwave emission characteristics of and their relationships to snowpack properties primarily and soil moisture secondarily. A self-contained mobile microwave facility will be assembled from components already existing in GSFC from on-going microwave field experiment programs and equipment transferred from other projects. Some subsystems will be acquired. At present Goddard has a total of 8 microwave radiometers at frequencies of 0.6, 1.4, 5.0, 6.6, 10.7, 18, 21, and 37 GHz, a data recorder, and a gasoline generator. The higher frequency channels will be replaced with the engineering model of Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) with necessary modification. In the event that the SMMR engineering model is not available an equivalent set of radiometers will be acquired. An existing crane and van system for housing the radiometers will be upgraded. This facility will be used exclusively for snowpack experiments during the winter season at sites with different snowpack characteristics, and at other times it will be used for soil moisture experiments at sites representative of US watershed and agricultural fields.

W80-70479 **677-22-10**
Goddard Space Flight Center, Greenbelt, Md.
SEASAT LAND EXPERIMENT FOR WATER RESOURCES
A. Chang 301-344-6507
(677-22-06)

The objectives of this effort are to assess the potential of the Seasat microwave sensors for soil wetness measurement

and runoff coefficient determination for water resources management; to determine the capability for flood mapping under adverse weather conditions; and to determine the all weather capability of measuring freeze/thaw lines lake ice conditions, drainage pattern, snow coverage and snow melting. Seasat SAR and SMMR will be evaluated for their potential in soil wetness monitoring and runoff coefficient determination. Microwave A/C underflights over several test sites plus Seasat microwave data will be analyzed to derive the correlation between observed radar return and measured runoff coefficients. The SAR imagery and relate them to freeze/thaw lines, lake ice conditions, snow coverage drainage pattern and flooded area (targets of opportunity), will be studied.

W80-70480 **677-22-11**
Goddard Space Flight Center, Greenbelt, Md.
SNOW AMW HYDROLOGY
A. Chang 301-344-6507
(677-22-06; 677-22-19; 677-22-22)

The objective of this research is to develop an algorithm for remotely monitoring the state of wetness and the water equivalent of snowpacks using active microwave sensors. Potential of the active microwave systems will be assessed for monitoring snowpack runoff prediction and water balance model. Measurements will be conducted at various test sites during the winter season using the truck-mounted microwave active spectrometer (MAS) system; analysis and interpretation of microwave data and ground truth data, the angular, spectral and polarization behavior of different snowpack conditions will be investigated; and algorithm for estimating snow wetness and water equivalent will be developed based upon the measurement.

W80-70481 **677-22-13**
Goddard Space Flight Center, Greenbelt, Md.
MODELING THE MICROWAVE EMISSION FROM MOIST SOILS
T. J. Schmugge 301-344-6059

The objective is to determine the feasibility of detecting subsurface moisture content utilizing multifrequency microwave radiometers. The approach will be to complete the analysis of aircraft radiometer data obtained during the 1975 flight over Phoenix test site, and compare these results with the predictions of a radiative transfer model for microwave emission.

W80-70482 **677-22-14**
Goddard Space Flight Center, Greenbelt, Md.
SOIL MOISTURE INTEGRATED PLANNING GROUP
A. Rango 301-344-5480
(677-39-05; 677-22-06; 677-22-08)

The objectives are to create a five year NASA plan for soil moisture research, integrating the requirements of agriculture, water resources, and climate; and conduct periodic meetings of the Soil Moisture Working Group to exchange information and to critique and guide NASA soil moisture research projects and plans. The approach will be to complete and update soil moisture plan initiated in FY-79; and continue periodic meetings initiated in FY-79 (approximately every 6 months) bringing together key researchers and users in the field of remote sensing of soil moisture focussing on information exhange and critique research.

W80-70483 **677-22-16**
Wallops Station, Wallops Island, Va.
AOL CONTOUR CHANNEL MAPPING
W. B. Krabill 804-824-3411

This program is applying an existing state-of-the-art airborne laser system (AOL) developed for oceanographic applications to mapping of land topography. The goal is to develop the technology required to apply airborne lasers to the various requirements for topographic information for hydraulic and hydrologic programs as expressed by the US Army Corps of Engineers (CE). Prior efforts from the FY-78 RTOP and the FY-79 AN have substantiated preliminary feasibility. During March 1979 a mission was flown over a CE test area (Wolf River, Tenn.). Analysis of this data is in progress, with excellent data products becoming available. Final comparisons with CE ground truth information should be available within 3-6 months. During FY-80 an additional data set in full foliage conditions will be collected and analyzed. A formal error analysis of the data products from the system as it currently exists will be conducted, providing baseline information to prioritize system improvements to meet CE requirements. Appropriate instrumentation and techniques for aircraft navigation/positioning will also be studied.

W80-70484 **677-22-18**
Goddard Space Flight Center, Greenbelt, Md.
HYDROLOGIC MODEL DEVELOPMENT LABORATORY
A. Rango 301-344-5480
(677-22-07)

A family of hydrologic models designed to optimally incorporate the current and anticipated capabilities of remote sensing technology will be developed. Appropriate portions of existing models will be selected and new algorithms developed where needed to make more efficient use of remote sensing capabilities, such as aerial sampling and repetitive observations. A laboratory will be established to serve as a forum for exchange of information among government and private hydrologists and remote sensing specialists.

W80-70485 **677-22-20**
Goddard Space Flight Center, Greenbelt, Md.
SNOW REMOTE SENSING WORKSHOP
A. Rango 301-344-5480

The objectives are to conduct a technical information exchange in the use of remote sensing techniques to monitor snowpack properties and in the use of ground truth methods for supporting data collection and define requirements of measurements and evaluate techniques and experiments to provide guidance for future research work. The approach is to: (1) conduct a workshop to bring together both snow hydrology users and snow microwave researchers to exchange information on requirements and capabilities; (2) present formal papers, conduct training and demonstration sessions on ground truth; and (3) invite key researchers and users.

W80-70486 **677-22-21**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELECTROMAGNETIC SUBSURFACE SOUNDING OF WATER TABLES
M. Bryan 213-354-5673

The objective of this study is to evaluate and demonstrate the capability of an airborne electromagnetic sounder to detect subsurface water tables at depths from 8 meters to 200 meters, particularly in arid and desert regions. This includes actual experimental verification by flying an airborne sounder presently under development at the Jet Propulsion Laboratory over well mapped regions with extensive ground truth in the form of available wells and hydrologic maps. An airborne electromagnetic sounder will be used over well mapped regions where the level of ground water is well known. The sounder data will be processed to enhance subsurface echoes. Analysis will be conducted to assess how to separate subsurface echoes from surface echoes. Subsurface echoes will be correlated with ground truth to verify if they are due to the presence of water tables or other types of inhomogenities.

W80-70487 **677-22-22**
Goddard Space Flight Center, Greenbelt, Md.
SNOWMELT MODELING FOR HYDROLOGICAL APPLICATION
A. Chang 301-344-6507
(677-22-06; 677-22-11; 677-22-19)

The objective of this effort are to develop a microscopic heat balance model for more understanding of the energy transfer within a snowpack; develop a scattering model to relate the active microwave backscattering responses from snowpacks; and calibrate the satellite data for input to distributed parameter hydrologic models. In addition to the information content research on remotely sensed data, theoretical models will be developed to utilize these data for better understanding of the snowmelt processes that related to energy budget and runoff prediction models. To accomplish the specific objectives: (1) a heat balance model will be developed to infer the thermal conditions in a

snowpack by comparing with available snow measurements; (2) available active microwave backscattering data will be analyzed for better estimation of the model parameters; and (3) compare the ground truth measurements with the satellite data for better understanding of the utilities of solar and thermal radiative models currently being developed.

W80-70488 **677-22-23**
Goddard Space Flight Center, Greenbelt, Md.
IRRIGATION SCHEDULING
V. V. Salomonson 301-344-6481
(677-22-06; 677-22-07; 677-22-08)

The objective of this effort is to analyze remote sensing observations acquired from satellites, aircraft, and ground based instrumentation over areas that are undergoing irrigation and where interaction with the Bureau of Reclamation Irrigation Management System (IMS) is occurring so as to obtain results that show the utility of these data in irrigation scheduling. The approach will consist of three parts: (1) assess and analyze existing thermal data from spacecraft and aircraft so as to obtain quantitative indications of potential application in irrigation scheduling; (2) assess utility of temporal LANDSAT data as a component of the model for estimating crop water requirement; and (3) evaluate the sensitivity of near and middle infrared observations for estimating plant stress related to water requirements.

W80-70489 **677-22-61**
Wallops Station, Wallops Island, Va.
ELECTROMAGNETIC SUBSURFACE SOUNDING OF WATER TABLES
J. T. McGoogan 804-824-3411

The objective is the remote sensing of features within the earth, particularly water tables and soil moisture. To accomplish this a new technique is proposed. An electromagnetic swept-frequency induction method will be used to probe, locate and identify targets within the earth. Depth of penetration varies inversely with frequency; thus as greater depths are probed longer time must be spent in sampling at the lower frequencies. The goal is an airborne system with a deep a penetration as possible. Specifically, the proposed plan has four parts: (1) development of a full-scale prototpye ground operated swept-frequency electromagnetic remote-sensing system (SFERS); (2) field tests of the swept-frequency system in a geologically known test area; (3) development of interpretation techniques for wideband spectral data; and (4) development of an airborne swept-frequency electromagnetic remote sensing system.

W80-70490 **677-23-01**
National Space Technology Labs., Bay Saint Louis, Miss.
DEVELOPMENT AND APPLICATION OF A REMOTE SENSING TECHNIQUE FOR THE INVENTORY AND EVALUATION OF COASTAL ZONE RESOURCES
M. K. Butera 601-688-3830

The objective is to develop a technique to evaluate the primary productivity and other resources related to carrying capacity of coastal wetlands using remotely sensed multispectral data. Algorithm parameters will be incorporated according to their importance in coastal environmental analysis and management practices. Research covered by this RTOP will address these elements: (1) conception of the productive capacity algorithm and its implementation as a technique; (2) the direct measurement of marsh biomass from LANDSAT radiance values; (3) the energy transport mechanism linking the marsh, as the nutrient source, to the estuary, as the consumer; and (4) comparison of spectral signatures of marsh grass species from simulated LANDSAT 3 and LANDSAT D data acquired by a field spectrometer.

W80-70491 **677-23-02**
National Space Technology Labs., Bay Saint Louis, Miss.
COASTAL ZONE INUNDATION MODEL DEVELOPMENT AND TESTING
R. A. Radlein 601-688-3830

The objective is to develop a coastal zone inundation model that uses remotely sensed data as a primary model input. By quantifying the effect of land cover on storm surge or other catastrophic inundation, the model can be used by coastal zone planners to predict or assess the consequences of wetlands alterations. Technique development is directed toward the blending of model technology with the advantages of remotely sensed data. In association with Louisiana State University, Center for Wetlands Resources, a candidate inundation model will be defined, programmed for computer use, and tested on a relatively simple coastal basin for which a large amount of historical data exists. Model improvements are anticipated in the use of vegetation density and land-to-water ratios (derived from LANDSAT data) to develop wetland frictional coefficients, a relatively difficult parameter to quantify for inundation models.

W80-70492 **677-23-03**
Langley Research Center, Hampton, Va.
LAMPEX - COASTAL SALT MARSH PROCESSES AND NEARSHORE PRODUCTIVITY
J. W. Campbell 804-827-2871

The objectives are: (1) to apply high-resolution remote-sensing techniques (i.e., the M2S and Langley TBAMS aircraft multispectral scanners) to studies of the sources and export of nonliving, organic rich particulate materials (detritus) from selected salt marsh environments; (2) perform optical studies on detrital particulates to establish specific spectral signatures as a junction of concentration in the visible-to-near IR spectral range, thus enhancing the capability for obtaining quantitative remotely sensed data; and (3) use Landsat and CZCS data to determine the extent and variability of regional nearshore color fronts adjacent to extensive salt marsh environments. The approach will be to obtain one major data set from each of the two experimental salt-marsh nearshore ecosystems (South Carolina, Massachusetts) during FY 1980. (Seasonal variability will be defined in the FY 1981/1982 period). Concurrent laboratory studies on spectral signatures will be coupled with sea-truth measurements to provide quantative data sets from the remotely sensed data. The low resolution satellite MSS data will be coupled with the aircraft MSS data to provide a comprehensive assessment of the role of salt-marsh ecosystems in nearshore productivity. These data will then be used to validate and then initiate an ecosystem model for the South Carolina salt marsh (model has been developed by the University of South Carolina).

W80-70493 **677-26-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SAR DIGITAL PROCESSOR
R. G. Piereson 213-354-3322
(506-20-25; 656-25-51; 677-41-04)

The purpose is to process designated sets of Seasat data to produce at least 70 synthetic aperture radar images in support of earth resource application studies. Each image will exhibit 25 m resolution and cover a 100 km X 100 km area. The processing will be performed using an Interim Digital Processor (IDP) which was recently developed at JPL. This same facility will be used to process some additional SAR images with funding from other sources. Also, the computer used in the IDP is shared with several other research tasks. The maintenance of the IDP equipment will be proportionally funded from this RTOP and other tasks which use the facility.

W80-70494 **677-27-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NASA AIRBORNE IMAGING RADAR FACILITY
E. R. Caro 213-354-3096
(677-36-05; 677-41-04; 146-40-04)

The airborne imaging radar facility operated for NASA by JPL has been instrumental in the progressive growth of synthetic aperture radar technology in recent years. Using the NASA/Ames Research Center CV990 as a test bed, a versatile and highly adaptive remote sensing capability has been made available to Earth Resources and Environmental Programs investigators and scientists performing studies and collecting data in the fields of meteorology, oceanography, polar ice mapping and pollution monitoring. The facility was instrumental in the development of synthetic aperture radars for SEASAT-A, SIR-A and VOIR. Some noteworthy accomplishments are: (1) imaging ocean surface wave,

internal waves, hurricanes and storms; (2) mapping geologic features, land use and water resources monitoring; (3) polar ice mapping and navigable lead detection; (4) surface vessel detection and pollution monitoring; and (5) precipitation detection. The work proposed here will provide a logical time phased program to enhance the reliability and expand the capabilities of a proven cost effective test facility. The users of this facility are engaged in investigative activities of interest to OSTA codes ER and EB. This RTOP is therefore being submitted for complimentary funding from both sources at a level consistent with the planned FY-80 activities.

W80-70495 **677-27-04**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADAR SPECTROMETER
W. E. Brown, Jr. 213-354-2110

The objective is to develop a very wideband radar system to measure surface power spectral density (PSD) curves and determine the sensitivity of the radar response to specific surface parameters as a function of wavelength. The PSD curves characterize surface geological units. In FY-78, the system design study was completed and the implementation approach was chosen. The goal is to scan from 300 to 30,000 MHz or 1 meter to 1 cm in wavelength. The baseline unit presently designed will scan from 2600 to 18,000 MHz, is mounted on a van or truck. In FY-79, the base line unit was constructed. Because the authorized funding level was $125K versus the $200K requested, (1) the baseline range was restricted, (2) all the major equipment was purchased via the loan pool which cut the equipment cost by a factor of 5, and (3) the low cost wide beam antennas were acquired to perform the principal calibration testing in FY-79 and FY-80. The annual loan pool cost is $27,500, and the equipment value is $173,000. If we cannot continue renting the equipment from the loan pool, the equipment will be returned to the pool, loaned to another user, and it is doubtful that it would be returned to the radar spectrometer with a usable calibration. In FY-80, the plan is to complete the interface with the truck, conduct surface measurements with the associated surface truth, replace the wide beam antennas with 10 deg beam antennas, expand to cover the range 1,200 to 6,000 MHz, and make field measurements to establish calibration.

W80-70496 **677-36-02**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED MULTITEMPORAL ANALYSIS METHODS
Jon D. Erickson 713-483-4017

This RTOP represents the second year of a 3-year research program originally based on a pair of LARS proposals submitted in response to the FY-79 AN. The FY-80 effort focuses on an evaluation of effects of misregistration using an FY-79 developed reformulation of the misregistration problem to establish effects on performance of multitemporal classification, and develop improved methods to analyze misregistered data. FY-79 developments in relaxation labeling will be continued.

W80-70497 **677-36-04**
National Space Technology Labs., Bay Saint Louis, Miss.
LOW-COST DATA SYSTEM
Sidney L. Whitley 601-688-3586

The primary objective of this effort is to define, and have industry build a prototype very low-cost data analysis system for processing LANDSAT MSS data to produce products that are needed by state and substate level organizations at a price that they can afford. A secondary objective is to make NASA developed data systems technology available to interested users.

W80-70498 **677-36-05**
Wallops Station, Wallops Island, Va.
RADAR DETERMINATION OF LAND COVER DATA
J. D. Oberholtzer 804-824-3411

Synthetic aperture radar (SAR) to be an acceptable remote sensing tool must give consistent results. The objective of this RTOP is to investigate the reliability of reconstructed SAR digital imagery. Problems to be studied include changes in pixel brightness as a function of instrument settings in reconstructing the image from its phase history, range related brightness variations across an image, pixel brightness variability as a function of the number of looks and variability of pixel brightness between separate images of the same target. The approach will be to use previously acquired data for this analysis. In November 1978 the ERIM X and L band radars as part of a NASA sponsored project acquired several images of the area including Wallops Flight Center. Calibration corner reflectors were placed and accurately located around the airfield. Because of WFC location targets of agricultural interest are included in the image. These images will be digitized at least twice and used as our primary data base.

W80-70499 **677-36-05**
Lyndon B. Johnson Space Center, Houston, Tex.
RADAR DETERMINATION OF LAND COVER DATA
M. Jay Harnage, Jr. 713-483-5853

The objective is to determine the usefulness of airborne and spaceborne active microwave sensors for land cover information. Special emphasis to be put on establishing the information content of radar data when used independently, and when used in conjunction with other sensors. The results will be used to support future spaceborne synthetic aperture radar (SAR) development, e.g., for frequencies, polarization, incident angles, etc. The primary basis for the tasks needed to meet the stated objective will be new airborne scatterometer and SAR data to be acquired during the course of this project. The secondary basis will be existing truck and airborne scatterometer data and existing airborne and spaceborne SAR data. The tertiary basis will be quasi-concurrently acquired Landsat MSS and Seasat L-band SAR data over LACIE intensive test sites in CY-78. SIR-A L-band SAR DATA to be acquired briefly in FY-80 may be useful for this project. Land cover information is primarily spectral in nature, and spatial information (patterns, shape, texture, shadow, size, location) from imagers and the temporal patterns of land cover change provides the means to assess land use. The SAR data will be used to develop and test a methodology to combine spectral, spatial, and temporal characteristics of a georeferenced SAR data set to produce land use classification. Standard and experimental pattern recognition techniques developed at NASA/JSC will be used.

W80-70500 **677-36-05**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADAR DETERMINATION OF LAND COVER DATA
M. L. Bryan 213-354-2739

The objectives of this RTOP are to study surface and aircraft scatterometer data in concert with active microwave (radar) aircraft imagery to determine the potential limits for extrapolation from surface observations to aircraft scatterometer and image data; to determine the accuracies of vegetation identification obtainable with active microwave imagery by itself and in conjunction with Landsat imagery, and to take advantage of existing Seasat-SAR data to characterize the contributions that may be made to accurate vegetation scene classification from orbital SAR of long wavelength and low incidence angle. The approach will be to assess (1) contributions made by imaging radars for accurate vegetation classification in particular agricultural crop identification, (2) the relations between surface and airborne scatterometry and imaging systems, (3) the degree to which active microwave data may be used individually and in conjunction with Landsat to improve identification accuracy, and (4) vegetation/radar relations with SEASAT A synthetic aperture imaging radar. Field sites to be employed are in Kern and Imperial Counties California, and Finney and Douglas Counties Kansas, covering arid irrigated areas and semi-arid and sub-humid sites so that a wide range of crop types, stages and conditions may be examined. Ground, aircraft and space scatterometry and imaging systems will be employed as follows: JPL & Kansas truck mounted radar spectrometers; JPL dual polarized L-Band imager; JSC dual polarized X and C band imagers; JSC X and C band scatterometers; SEASAT-A/SAR; LANDSAT (coincident with aircraft and where feasible previous SEASAT radar).

W80-70501 **677-36-06**
Goddard Space Flight Center, Greenbelt, Md.
OFF NADIR VIEWING ANALYSIS
D. W. Deering 301-344-8866
(677-36-07; 677-11-01)

The objective is to determine the relationships between plant canopy variables and spectral reflectance from off-nadir view angles and to develop techniques to efficiently use spectral measurement data acquired in an off-nadir pointing mode. Ground based nadir and off-nadir spectral measurements will be taken in phytologically important spectral regions for a variety of agronomic and natural vegetation canopies under a useful range of conditions. Intensive plant, soil, and irradiance measurements will be acquired concurrent with spectral measurements to develop a suitable data base for mathematical modeling, which will be used to (1) assist in the evaluation of off-nadir spectral data; and (2) develop techniques useful for ground parameter estimation. Airborne multispectral scanner data will be collected in a multiflight-line mode to acquire different off-nadir looks of the same selected cropland and natural vegetation sites to assess classification and mensuration accuracy, signal return, etc., at the various off-nadir looks. Mathematical techniques for adjusting off-nadir spectral data to nadir and for overlaying and registering off-nadir spectral data with base maps and other data will be investigated.

W80-70502 **677-36-07**
Goddard Space Flight Center, Greenbelt, Md.
ATMOSPHERIC CORRECTION TECHNIQUES
W. L. Barnes 301-344-8117
(677-37-01)

The objective is to develop techniques for identifying, quantifying, and correcting radiometric errormos caused by atmospheric effects on visible and near infrared remote sensing of the earth's surface. The removal of atmospheric effects from visable and infrared radiometric data will depend on either the proper utilization of data from existing sensors or the design of new instrumentation. In either case, however, an understanding of the spatial and temporal variability of atmospheric aerosols is essential to the development of such a correction. Field experiments to measure spatial frequencies of the horizontal inhomogeniety in atmospheric optical thickness will be developed and a series of automated solar spectral transmissiometers necessary to implement these experiments will be designed, fabricated, tested, and calibrated. Ground based lidar experiments to measure temporal variation of atmospheric turbidity and to support the calibration of the solar transmissometers will continue. This TROP supports the following programs: (1) MSS, (2) thematic mapper, and (3) STS-2/OCE (ocean color experiment). These, in turn, support corp classification, world food supply, and ocean bioproductivity.

W80-70503 **677-36-08**
Lyndon B. Johnson Space Center, Houston, Tex.
TECHNICAL DEVELOPMENT PROCESSOR SUPPORT
John C. Lyon 713-483-5528

Data processing and analysis support for the various AgRISTARS projects to be conducted at JSC is to be accomplished in a locally centralized data handling facility, the Earth Observations Data Laboratory (EODL). The EODL is to be developed insofar as possible from various transfers and reutilization of existing JSC equipment, with procurement of replacement or augmenting components of the EODL to be effected only as necessary for accomplishment of AgRISTARS objectives. The objective of this RTOP is the timely replacement of several key elements of the proposed EODL equipment configuration; viz.: (1) image film recording system (FY-80); (2) interactive color image analysis stations (FY-80); and (3) Landsat preprocessing system (FY-81).

W80-70504 **677-37-01**
Goddard Space Flight Center, Greenbelt, Md.
MULTISPECTRAL LINEAR ARRAYS
Leslie L. Thompson 301-344-6609
(677-37-02; 677-39-02)

The objectives are to develop and test advanced monolithic and hybrid array technologies for future remote sensing applications; to design, build, and test demonstration sensors for use as field research and/or aircraft instruments. User needs for future sensors were used to identify detector technologies with the best potential for future applications. Sample quantities of a number of detector array technologies were delivered to Goddard. An existing sophisticated in-house laboratory measures the performance of the arrays. Emphasis is placed on developing array technology for the 1 micron to 2.5 micron spectral regions. In addition, demonstration sensors are built-up in-house to evaluate performance when viewing real world targets. This RTOP supports the following programs: (1) earth resource survey; (2) LANDSAT; and (3) multispectral resource sampler and shuttle payloads. These, in turn, support food resources, mineral resources, environment, and disaster assessment.

W80-70505 **677-37-02**
Goddard Space Flight Center, Greenbelt, Md.
REDUCTION OF OPTICAL CROSSTALK IN CHARGE-COUPLED PHOTODIODE ARRAYS (CCPDA)
Leslie L. Thompson 301-344-6609
(677-27-01; 677-29-02)

The objective is to optimize the radiometric performance of multispectral linear array (MLA) sensors for remote sensing by reducing the internal optical crosstalk in silicon solidstate detector arrays. Low noise and high quantum efficiency will be provided. A 32-element charge-coupled photodiode array will be designed, fabricated, and tested which uses a thinned substrate with backside metalization to minimize the photogenerated carrier crosstalk in high resolution detector arrays. An alternate approach could use a buried contact and epitaxial layers. An 21-month development program is planned. This RTOP supports the following programs; Earth Resource Survey, Landsat, OERS, and MRS. These, in turn, support the following objectives: (1) food resources, (2) mineral resources, (3) environment, and (4) disaster assessment.

W80-70506 **677-37-06**
Lyndon B. Johnson Space Center, Houston, Tex.
EXTENDED SCENE RADAR CALIBRATION
R. G. Fenner 713-483-3073

The purpose is to establish a method to verify the precision and accuracy of scatterometers and imaging radards used for remote sensing on the JSC aircraft. The precision and accuracy of microwave sensors must be established and verified before there can be meaningful results in the investigations, such as soil moisture, where quantitative, traceable measurements of radar backscatter are required. During FY-78, JSC implemented and verified the hardware and software measurement techniques to perform this RTOP. FY-79 activity consisted of comprehensive test series utilizing the 13.3 GHz, 4.75 GHz, and 400 MHz aircraft scatterometers. Correlating ground measurements were taken at 13.3 GHz, 4.75 GHz and 1.6 GHz with the ground system developed during FY-78. Multifrequency scatterometer data base were gathered at Northup Strip, White Sands Missile Range, Jornada Experimental Range, NM, and Death Valley, CA. Analysis of these data sets is currently underway. FY-80 activity will consist of gathering a second and confirming data set on Northrup Strip, further investigation of row effects on a simulated agriculture site at Jornada Experimental Range, NM, and classification and correlation of roughness units in Death Valley, CA, with radar imagery.

W80-70507 **677-39-02**
Goddard Space Flight Center, Greenbelt, Md.
MULTISPECTRAL RESOURCES SAMPLER (MRS)
W. H. Meyer 301-344-5784
(677-37-01; 677-37-02)

The objective is to: (1) define a solid state multispectral pointable imager capable of improving temporal, spatial & spectral sampling of the Earth's resources, and (2) conduct engineering & applications science studies to provide prespecification activities to enable a Multispectral Resources Sampler (MRS) instrument development. Past studies have addressed the design of solid state multispectral sensors. A MRS pointable imager for a follow-on Landsat mission received particular emphasis. This RTOP will provide short term engineering studies for a detailed optical

design, registration requirements, on-board signal processing and unique interface problems envolved in the MRS technology. In support of MRS specification development the ad hoc science working group will continue addressing sensor utilization from the user point of view including bidirectional modeling, atmospheric correction techniques, polarization studies, on-board data compression methods, spectral band selection, radiometric sensitivity considerations, off axis pointing requirements & overall sensor management planning. Engineering problems related to linear array characterization and calibration will be defined and efforts initiated. A detailed system and interface specification will be written.

W80-70508 **677-39-04**
Goddard Space Flight Center, Greenbelt, Md.
GRAVSAT MISSION STUDIES
Edward A. Wolff 301-344-7496

The objectives are: (1) to specify the optimal Gravity Field Satellite (GRAVSAT) mission that meets the requirements for intermediate wavelength (100-1,000 km) gravity information, (2) to determine the extent to which the proposed mission can determine the gravity field and geoid of the heart, and (3) to study the applicability of GRAVSAT data to ocean circulation and solid earth geophysics. The gravity field capability and requirements will be determined by modifying existing computer programs to determine the effects of surface force compensation errors, refraction errors, tidal model errors, orbital state errors, gravity field model errors, and satellite-to-satellite range rate measurement errors on the estimation of the earth's gravity field and geoid. The tracking and spacecraft requirements will be determined to define the optimal mission. This RTOP supports the Geodynamics and Geophysics programs.

W80-70509 **677-39-05**
Goddard Space Flight Center, Greenbelt, Md.
SOIL MOISTURE MISSION STUDY
T. J. Schmugge 301-344-6059
(677-22-02; 677-22-14; 677-22-06)

The objective of this study will be to evaluate the capabilities for the remote sensing of soil moisture from space and to define a potential system for implementing this capability. The sensor approaches to be considered include: (1) passive microwave, (2) active microwave, and (3) thermal infrared and reflected solar. The best practical combination of these approaches will be selected for a potential space system. The capabilities of these sensor approaches will be studied using the understanding and information based on existing data sets and modeling. These capabilities will be compared with current and projected user needs for soil moisture information before a potential space system is defined.

W80-70510 **677-39-06**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADVANCED GEOLOGY MISSION STUDY
A. F. H. Goetz 213-354-3254

The objective of this study is to define a concept and an instrument complement for an advanced geology mission utilizing advanced sensor systems such as spectral infrared imaging, microwave imaging, laser reflectance and fluorescence, and other techniques as appropriate. The approach will focus initially on identifying the need for improved remote sensing data for geological mapping. Potential users of the data will be determined and an informal working group established. The working group will help define (1) requirements for data products, (2) identify mission requirements, (3) determine sensor complement, and (4) develop concepts for integrating mission data with data acquired from other satellites. The study will also attack the question of the relative merits of free-flyers versus shuttle. Requirements for ground data management will also be identified.

W80-70511 **677-39-07**
Lyndon B. Johnson Space Center, Houston, Tex.
EARTH RESOURCES SYNTHETIC APERTURE RADAR (ERSAR)
M. Jay Harnage, Jr. 713-483-5853

The objective of the ERSAR Program is to evaluate and prove the utility of spaceborne imaging radar data for specific applications in Earth Resources. These applications evaluation results will drive the system characteristics and the technology developments required for a spaceborne imaging radar new start in FY-83 and launch in FY-87. To accomplish the stated objectives, the ERSAR Program proposal, planning, and implementation approach will be patterned similar to that used for approval of two previous major earth observations program elements: the LANDSAT-1 and SEASAT programs. An Applications Advisory Committee has been established consisting of applications specialists from federal agencies, industry, and universities, plus supporting science and engineering talent.

W80-70512 **677-39-08**
Goddard Space Flight Center, Greenbelt, Md.
THERMOSAT MISSION ADVANCED STUDY
J. L. Barker 301-344-8978

The objective is to define, for purposes of terrestrial applications, the sensors, missions, ground systems and analyses required for a thermal sensing satellite system. The resulting thermodynamic information would be used to support applied research in geology, agriculture, forestry, land use, water resources and geophysics. This study will consist of two tasks. The Systems Definition Task will prioritize needs for thermosat by application, quantify and prioritize requirements within an application, and prioritize options for sensors, missions and ground systems to meet requirements. The research Feasibility Task will: (1) review scientific results, (2) develop at least one illustrative example, (3) review required models by application, and (4) prepare research plans to develop these models. Both tasks will be reviewed and advised by a scientific working group.

W80-70513 **677-39-09**
Lyndon B. Johnson Space Center, Houston, Tex.
FOLDABLE PLANAR ARRAYS FOR SAR'S
H. A. Nitschke 713-483-3073

The objective of this plan is to define a foldable antenna system to support the SIR-A follow-on flights and ERSAR. The SIR-A antenna was designed and implemented in the extended and fixed orientation to meet the constraints imposed by the SS2 mission. Operational shuttle missions will require efficient use of the payload bay space such that the antenna system must be folded for launch and unfolded for on-orbit usage. Maximum use will be made of the existing hardware and design from the SIR-A and SEASAT SAR antenna developments. Antenna parameters that affect radar system performance, such as size, shape, gain, sidelob level, beamwidth, bandwith, etc., will be considered. The end produce of this effort will be a preliminary design of a antenna system which will satisfy the requirements for reflight of SIR-A and/or ERSAR.

W80-70514 **677-41-02**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
JOINT NASA/GEOSAT TEST CASE STUDIES
M. Abrams 213-354-6927
(677-41-03; 677-41-04)

The primary objective is to develop, evaluate, and demonstrate improved remote sensing techniques for petroleum and mineral exploration problems. Cooperative test cases have been established with the Geostat Committee, Inc., a nonprofit organization representing a wide spectrum of mineral and petroleum exploration companies. Test sites have been selected at known and thoroughly explored representative occurrences of the chosen commodities. The approach is to continue the following activities: (1) develop exploration models by literature review, consultation with experts, and laboratory studies and determine remote sensing parameters applicable to exploration programs; (2) obtain Geosat-provided ground truth data for the selected test sites. Data includes geologic maps, geophysical, and geochemical data; (3) continue to evaluate computer processed Landsat multispectral data; (4) continue to evaluate photographic data, including NASA acquired U-2 aircraft data and Skylab multispectral photography; (5) continue computer processing and evaluation of NASA-provided aircraft data including visible and near infrared multispectral scanner data, thermal infrared scanner data, radar data, and passive microwave data; (6) register all data sets from (2), (3), (4), and (5); (7) continue

to acquire and analyze field and helicopter reflectance data obtained with JPL's Portable Field Reflectance Spectrometer and Portable Field Emission Spectrometer; (8) evaluate all data to assess the utility of presently available remote sensing information for resource exploration based on current exploration models; and (9) determine the need and recommend parameters for future geologic satellites or aircraft systems based on analysis of the above.

W80-70515 **677-41-03**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
IMPROVED ROCK TYPE DISCRIMINATION
A. B. Kahle 213-354-7265
(677-41-02)

The objectives of this study are to improve our abilities in mineralogic and lithologic discrimination by remote sensing. The approach is to acquire data in the field, in the laboratory, from aircraft, and from satellite, to develop new instruments for data acquisition and to refine techniques for data analysis. Three types of data are to be systematically studied: (1) very high spectral resolution reflected infrared data (1 to 2.5 microns; (2) moderate resolution mid-infrared emission data (3-14 microns); and (3) surface thermal properties such as thermal inertia, derivable from temperature measurements. The newly completed 10 channel hand-held ratioing radiometer (HHRR) will be used in the field at the Shuttle Multispectral Infrared Radiometer (SMIRR) and other test sites to test the value of very narrow band filters (.02 microns) in the 2-2.5 microns region for mineralogic discrimination, particularly among the clays and carbonates. Results will be related to data acquired during the SMIRR aircraft flight tests. Construction will begin on a new high resolution spectrometer head for the PFRS. The instrument will have a resolution of 0.005 microns and cover the range 1.5-2.5 microns. The existing spectral measurements from the laboratory will be augmented with a high resolution spectrometer covering the 0.4-2.5 microns range. The JPL Portable Field Emission Spectrometer (PFES) will be operated at various test sites in Arizona, Nevada and Utah to obtain in situ spectra in the 3-14 microns region. Data will be correlated with multiband thermal images of the Tintic mining district and analyzed during FY-79. Statistical analysis techniques will be applied to the field spectra to determine the best spectral bands for discrimination among silicate and carbonate rocks. Thermal inertia measurements of a number of natural surfaces will be taken in the field. A simple device has been constructed to make measurements independent of insolation. Results will be compared to data acquired by aircraft and HCMM.

W80-70516 **677-41-04**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ROCK TYPE/MW TECHNIQUES (RADAR GEOLOGY)
C. Elachi 213-354-5673
(677-41-02)

The objective of this research activity is to evaluate the potential and capability of imaging radar sensors for geologic mapping. Of particular interest is the capability of the imaging radar to acquire information on geologic structures and features which would help in assessing and exploring the Earth's mineral and energy resources. Part of this objective is to assess the synergism of combing multispectral multipolarization radar data with other types of remote sensing data obtained in different regions of the electromagnetic spectrum (i.e., IR, visible, thermal IR). To meet the above objectives, a five-year plan (1978-1982) has been developed which addresses the different problems to achieve a good understanding of the information content in radar imagery and of the radar signature of different geologic surfaces and features. Aircraft and spacecraft data would be obtained over well mapped test sites. The analyses will emphasize direct comparison of the radar signature to ground truth information and the spectral signature of other sensors, in an attempt to develop an understanding of the geophysical information that could be extracted from the radar image. The JPL airborne radar will be the main radar sensor used in this effort; however, the JSC airborne radar and available data obtained with Goodyear and Motorola systems will also be used. The test sites will also be covered by Seasat-A and SIR-A radars. This work will be closely coordinated with the JPL/GeoSat activities ongoing under a separate task. In FY-80 the emphasis will be on three aspects: (1) determine to what extent the surface small-scale structure in sedimentary and crystalline terranes can be defined by using multiple frequency and polarization data; (2) apply advanced techniques for identifying lineaments, and (3) develop algorithms for discriminating rock types based on drainage network statistics.

W80-70517 **677-41-06**
Wallops Station, Wallops Island, Va.
LASER INDUCED FLUORESCENCE OF GEOLOGICAL MATERIALS
F. E. Hoge 804-824-3411

The objective is to evaluate, develop, and demonstrate the utility of wide area, synoptic quantitative geological exploration, and mapping by the use of laser induced fluorescence. Laser induced fluorescence (LIF), as a new technique, will first be evaluated by measuring the fluorescence conversion efficiency of several well known fluorescent minerals, as fluorite, dolomite, apatite and garnet, in the laboratory. Results will be compared with efficiencies known from successfully remote-sensed materials as oil and surface dye tracers, to determine if sufficient signal return strength can be obtained from these natural minerals then excited by an airborne sensor. No new sensor development is necessary; the existing Wallops airborne lidar fluorosensor will be used for all field tests. Initial tests will include fluorescence feasibility studies of large natural samples using the hangered airborne system at 152 meter (500 ft) distance. Following successful ground testing, an airborne program will be undertaken, with actual sites to be specified.

W80-70518 **677-41-07**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CHEMICAL WEATHERING OF ROCKS IN ARID REGIONS
A. F. H. Goetz 213-354-3254
(677-41-03)

The objective is to undertake a multi/disciplinary study of the properties of weathered surfaces of rocks in arid regions as a means of expanding the usefulness of multispectral remote sensing techniques for geologic mapping. In particular the interest is in describing the effects of desert varnish. The work will involve mapping and sampling weathered surfaces on different rock types in different microclimates. Emphasis will be on understanding the geologic setting for samples to be measured in the laboratory. X-ray diffraction, infrared spectroscopy and other analyses will be made on selected samples. Visible and IR reflectance spectra will be obtainable from analyzed samples. Respiration and photosynthetic activity measurements will be made for different weathered rock types and these activities will be monitored over a period of a year. Thin layer chromotography and mid IR spectroscopy will be used to identify organic constituents of weathered rock surfaces.

W80-70519 **677-42-01**
Goddard Space Flight Center, Greenbelt, Md.
GEOLOGICAL INVESTIGATIONS USING SATELLITE AND RELATED DATA
Kenneth T. Meehan 301-344-5554
(677-42-02; 677-42-03)

The objectives are to investigate effects of physiochemical properties of mineralized areas and/or rock lithologies on the spectral response of overlying vegetation and to conduct multivariate geological analysis of both satellite and ground data from a major geologic feature, and to evaluate the contribution of satellite data to the overall systhesis. The approach is to conduct (1) geobotanical study to modify existing software within Geographic Information System; link statistical analysis capabilities to GIS such as descriptive statistics, spatial analysis, and multivariate analyses; collect, format, and analyze geobotanical data types; (2) multidata base geologic study to select well-studied major geologic feature, develop and adapt multivariate statistical procedures; collect and analyze numerous data types to predict specific mineralized targets; further utilize multisource data in feature analysis; and analyze results and critically evaluate the contribution of satellite data to synthesis.

W80-70520 **677-42-02**
Goddard Space Flight Center, Greenbelt, Md.
FUNDAMENTAL RELATIONSHIPS IN GEOBOTANY
Alicia Watson 301-344-5554
(677-42-01; 677-42-03)

The objective is to establish in which portions of the electromagnetic spectrum changes in plant biochemistry and physiology due to geologic factors can be detected. The goals of the research are to use this information as input to sensor and atmospheric models and to develop a set of recommendations and a tentative design for sensor systems used in geobotanical exploration. The approach is to (1) establish in a controlled experiment, relationships between the concentrations of metals in growing media and the values of biochemical (e.g., chlorophyll a/chlorophyll b ratios and levels of pigment-protein complexes) or physiological variables (e.g., leaf number, leaf area, plant height and evapotranspiration rate) in the plant; (2) use various techniques to find those portions of the electromagnetic spectrum which mimic the variations found in the biochemical and physiological variables; and (3) using results from 2 and related RTOP's it defines parameters for sensor, canopy, and atmospheric models to simulate airborne and orbital sensing systems.

W80-70521 **677-42-03**
Goddard Space Flight Center, Greenbelt, Md.
AIRCRAFT SPECTROMETER ANALYSIS OF GEOBOTANICAL TEST SITES
Mark L. Labovitz 301-344-7122
(677-42-01; 677-42-02)

The objective of this project is to collect ground truth and remotely sensed data over specific geobotanical test sites for construction of a geobotanical data base within the Geographic Information System (GIS) established at GSFC. Funding is provided also for portions of analyses by principal investigators. The approach is to (1) select geobotanical test sites; (2) fly a number of different remote sensing systems over the same sites, including: Fraunhafer Line Discriminator, Columbia/Collins high spectral resolution aircraft spactrometer, laser fluoroscanner, linear array pushbroom radiometer, thematic mapper simulator; (3) collect ground truth data: agronomic, botanical, geographic, geologic, meteorologic; and (4) analyze data by principal investigators; raw and reduced data forwarded to GSFC for inclusion into data base.

W80-70522 **677-45-01**
Goddard Space Flight Center, Greenbelt, Md.
CRUSTAL MODELING USING SATELLITE POTENTIAL FIELD DATA
G. D. Mead 301-344-8470

The objective is to develop methods for using satellite magnetic and gravity data as tools for deriving geologic/geophysical models of subsurface crustal structure, composition, and evolution. Anomaly maps from the Pogo satellites and satellite derived gravity and geoid maps are studied to identify regions suitable for development of geophysical models. Techniques are developed to invert the satellite data to models of subsurface magnetization and density. Correlative data such as heat flow and seismic data are gathered and analyzed together with the satellite data to reduce model ambiguities. Classes of recurring features, such as spreading ridges and rifts, are studied globally to determine similarities and differences and their implications for plate tectonics. Final models will include an assessment of the regional evolution and its relation to possible emplacement of oil and mineral resources.

W80-70523 **677-45-03**
Goddard Space Flight Center, Greenbelt, Md.
PETROLOGIC AND GEOPHYSICAL STUDIES OF THE SOURCE OF LONG WAVELENGTH CRUSTAL MAGNETIC ANOMALIES
H. H. Thomas 301-344-5412
(677-45-01; 677-45-04)

The objective is: (1) to further our ability to interpret Magsat and Pogo magnetic data through development of our understanding of the magnetism and petrology of crustal rocks; (2) to develop a data set of magnetic and corresponding petrologic properties of the rocks and minerals responsible for long wavelength satellite magnetic variations; and (3) to model the magnetic mineralogy of crustal regions using this data set along with theoretical and experimental petrology. Magnetic properties are determined of xenolithic rocks characteristic of the earth's crust and upper mantle. This data will define the top and bottom of the earth's near surface magnetic layer. Magnetic properties of rocks in regions of satellite anomalies are measured. Magnetic mineralogy is integrated into phase equilibria studies so as to enable extrapolation of measured surficial rock properties to depth. Rocks characteristic of various tectonic settings and determine their petrologic and magnetic properties are obtained. These data will serve as inputs to theoretical petrologic models to infer sources when actual rocks are unavailable.

W80-70524 **677-45-04**
Goddard Space Flight Center, Greenbelt, Md.
MAGSAT CORRELATIVE STUDIES
R. A. Langel 301-344-6565
(677-45-01; 677-45-03)

The objective is to gather correlative data and utilize it to refine crustal geological and geophysical models based on Magsat data. Correlative data will include aeromagnetic data and seismology data. The correlative data will be used to verify the accuracy of the Magsat data. The approach will be to collect and compile aeromagnetic and shipborne magnetic data for regions of interest determined from study of the satellite anomaly map; collect seismic data for regions of particular interest identified by preliminary regional modeling of satellite anomaly data; and utilize the seismic data to refine the regional models; and to determine satellite position arcs of several minutes duration from appropriate STDN stations. These position were compared with those determined from VHF Doppler to estimate the accuracy of the position determination.

OFFICE OF SPACE SCIENCE

Planetary Geology

W80-70525 **151-01-20**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY SURFACE PROCESSES
W. C. Phinney 713-483-3816

The broad objective of the study of planetary surface processes is to develop a coherent body of data on planetary surface processes which can be used to design planetary missions and to interpret data as well as place boundary conditions on planetary evolution. Future exploration of Mars and other planets includes surface analysis and sample return missions. The development of these missions requires suitable instrumentation for analyses on the surface of Mars and analogues of Martian surface material. Analogues not only place boundary conditions on the evolution of Mars but also permit on Earth the evaluation of the characteristics of Martian surface instrumentation. Specific objectives are: (1) to determine through detailed grain-by-grain studies of several terrestrial soils the processes and history that can be deduced through such data, (2) to devise techniques that optimize sample preparation, data collection, and data processing of soils to extract the maximum amount of information, (3) to characterize the gases released by thermal decomposition of Martian surface analog materials and evaluate the feasibility of accomplishing such analyses in situ, (4) to simulate the mechanical, chemical and radiative weathering environments on Mars and Venus and study in detail the resulting products of a number of materials subjected to such conditions.

W80-70526 **151-01-50**
Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF MAGNETOMETER DATA: VENUS AND MERCURY
N. F. Ness 301-344-8112

One primary objective of the Mariner 10 mission was the study of Mercury and its environment in the solar wind. A field

intrinsic to the planet was discovered. The origin of the field cannot be uniquely determined, and can be due to an active dynamo, a remanent field, or both. Models have been developed for remanent fields, the crucial point for acceptance centers on the comparison of the average lunar sample magnetization with values required for thermoremanent models for the subCurie point crust and mantle-assuming iron to be the mineral. The models require a material magnetization of up to 2 orders of magnitude larger than the lunar sample value. The magnetization level for a sample depends on % free iron or other magnetic phases, the temperature dependence of magnetization, the global or regional coherence of remanent fields, material composition, and the mechanism of magnetization. The reason why none of the above were considered in any of the proposed models, is simply that the data is non existent. Spectrophotometric curves suggest a surface which is particulate and which has experienced the same space weathering phenomena as the moon, but there is no direct evidence that lunar and Mercury surfaces contain similar amounts of free iron. Continuing studies which will be completed in the next year will provide the quantitative information, which can be scaled, on magnetization in FeNi alloys which can then be used to properly evaluate the remanent field models for Mercury.

W80-70527 **151-01-60**
Ames Research Center, Moffett Field, Calif.
PLANETOLOGY: AEOLIAN PROCESSES ON PLANETS
W. L. Page 415-965-5404

The objective of this activity is to determine the parameters governing aeolian (wind) processes in various planetary environments by means of wind tunnel simulations, Earth analog studies, and analyses of spacecraft data. The approach will be to conduct experiments using the Martian Surface Wind Tunnel to study at various atmospheric pressures: (1) conditions for the initiation and sustainment of particle movement; (2) model studies of erosion and deposition around various landforms; (3) rates of erosion of various natural materials; and (4) study by scanning electron microscopy of surface textures produced by wind abrasion under Martian conditions. In addition, field experiments will be conducted to determine threshold conditions under natural conditions and to determine aeolian patterns around full-scale landforms, and the use of a field-portable wind machine for studying the dynamics of dune migration. Finally, spacecraft data will be analyzed to interpret aeolian processes on Mars and Venus.

W80-70528 **151-01-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETOLOGY
D. E. Thompson 213-354-6129

The proposal for Planetology consists of eight studies to be carried out in FY-80. Studies are being performed in a variety of disciplines, including volatile evolution, photogeology interpretation, geomorphology, surface structural features and weathering.

W80-70529 **151-02-60**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF PLANETARY BODIES
J. B. Pollack 415-965-5530

The objective is to obtain a better understanding of selected problems pertaining to planetary surface phenomena, the composition, structure and evolution of planetary bodies and their satellites, and the origin of the solar system by means of theoretical investigations employing the results of spacecraft and ground-based experiments. Theoretical knowledge, physical insight, and mathematical modeling techniques are used, together with astronomical and geological data, to construct self-consistent mathematical descriptions of planetary processes and structure. Analysis and interpretation of the results of these model calculations are applied to such topics as: the evolution of Jupiter and wind-blown surface features on Mars, and climatic change on Mars.

W80-70530 **151-02-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INSTRUMENT DEVELOPMENT
J. B. Wellman 213-354-7222

The proposal for Instrument Development consists of two tasks to be carried out in FY-80. Tasks are being performed in two disciplines: visual and IR imaging spectrometry and electrolytic water analysis.

W80-70531 **151-03-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY CARTOGRAPHY
R. F. Jurgens 213-354-4974

The objective is to enhance the value of prior Goldstone radar observations relative to planetary cartography and provide other science related to navigation, microwave scattering theory, general relativity, and spin dynamics of planetary bodies.

Extraterrestrial Materials Research

W80-70532 **152-01-40**
Lyndon B. Johnson Space Center, Houston, Tex.
LUNAR SAMPLE ANALYSIS
J. W. Harris 713-483-3274

Lunar sample analysis is a multidisciplinary effort carried out by individual scientists and teams. It consists chiefly of three program areas (with the estimated number of grants/contracts to be awarded): (1) mineralogy - petrology - (10 grants/contracts), (2) geochemistry and isotope studies - (15 grants/contracts, and (3) physical properties - (5 grants/contracts). The lunar sample analysis program is a continuing effort aimed at understanding the origin and history of the Moon, including its age, chemical characteristics, mineral composition, and physical properties. Data obtained also provide valuable information on the early history of the Earth, the past activity of the Sun, and planetary processes. The results also provide baseline data that will aid in the planning of future planetary missions.

W80-70533 **152-02-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: LABORATORY AND ANALYTICAL STUDIES
R. J. Williams 713-483-2781
(152-04-40; 153-06-40)

The objective of this research is to produce a quantitative understanding of the chemical and physical properties of planetary materials and of the processes by which these materials have formed and evolved. This quantitative understanding is obtained through analytical and experimental studies of lunar samples, meteorites, cosmic dust, and closely related synthetic or terrestrial materials. A variety of analytical techniques--X-ray fluorescence, instrumental neutron activation, solid source and gas mass spectrometry, gas chromatography, ion and electron microprobe analysis, and scanning and transmission electron microscopy--are used, as appropriate, to quantitatively determine the physical, chemical, and mineralogical properties of planetary materials. Experimentation under controlled temperature, pressure, oxidation-reduction, and shock conditions is used to study the effects of physical processes which may have operated during the formation and evolution of planetary materials.

W80-70534 **152-03-60**
Ames Research Center, Moffett Field, Calif.
STUDIES OF THE DISTRIBUTION OF ELEMENTS AND MINERAL PHASES AMONG METEORITES
H. P. Klein 415-965-5094

The objective is: to understand the origin and evolution of meteorites through the study of their chemistry and mineralogy, and to gain insight into the conditions and processes that prevailed at the time of the solar system's origin. The abundance, isotopic composition and distribution of selected elements and the occurrence and distribution of various minerals in meteorites will be examined. Systematic searches for elemental, isotopic and mineralogic-petrologic correlations between meteorites and within a meteorite will be made so as to elucidate physical-chemical relationships in the meteorite population. These relationships will be used to test the hypothesis that meteorites originated as condensates from the cooling solar nebula.

W80-70535 **152-03-80**
National Aeronautics and Space Administration, Washington, D.C.
ORIGIN AND COMPOSITION OF METEORITES
B. M. French 202-755-3760
(195-20-07)

The objective of this program is to increase our knowledge about the nature, composition, age, origin, and history of meteorites by means of direct analysis of meteorite specimens and by related theoretical and observational studies. A wide variety of analytical techniques are used to obtain information about meteorite mineralogy, chemical compositions, radiometric ages, cosmic-ray-exposure ages, isotopic compositions, particle track characteristics, etc. This knowledge will improve our understanding of the physical and chemical processes present during formation of the solar system, the nature and history of cosmic radiation in interplanetary space (use of meteorites as space probes), and the genetic relations between meteorites and asteroid families. This research also supports ongoing lunar sample studies by providing important comparative data and by testing and calibrating new analytical techniques.

W80-70536 **152-04-40**
Lyndon B. Johnson Space Center, Houston, Tex.
SAMPLE PRESERVATION AND DISTRIBUTION
P. Butler, Jr. 713-483-3274

This RTOP supports the Lunar Sample Analysis Program by providing for maintenance of the lunar sample collection under controlled environmental conditions; preparation of samples for study by principal investigators; research on techniques of preparation and preservation of lunar and meteoritic samples; documentation of the distribution and use of samples; preparation and publication of sample information catalogs containing petrographic, inventory, and processing data; and implementation of the sample control system. Operation is carried out by a staff of civil service scientists and administrators directing a laboratory effort undertaken by contractor personnel. Most effort is involved in preparation of sample materials for approximately 70 domestic and 22 foreign principal investigators.

W80-70537 **152-05-40**
Lyndon B. Johnson Space Center, Houston, Tex.
JSC INSTITUTIONAL SUPPORT - PLANETARY MATERIALS
M. B. Duke 713-483-4464

This RTOP provides for support by JSC of an institutional nature necessary to the planning and conduct of OSS planetary materials programs. It provides JSC support services for the annual Lunar and Planetary Science Conference, and the visiting scientists programs of the NASA. Support services include transportation, logistics, publications, library, audio-visual, photographic, data processing, fabrication, and in-house laboratory utilization. A certain amount of inhouse laboratory operations are dedicated through this plan to general program support such as that provided to preproposal definition studies, specialized studies for the sample curator, and mission support activities. This plan also supports a continuing study by inhouse scientists to define the role of the Planetary Program. This study systematically identifies gaps in current knowledge and defines specific scientific requirements for future space missions.

Planetary Geochemistry and Geophysics

W80-70538 **153-02-40**
Lyndon B. Johnson Space Center, Houston, Tex.
EXPERIMENTAL STUDIES
W. C. Phinney 713-483-3816

The objective of this study is to describe the necessary parameters that will allow quantitative comparisons of spectral features measured remotely under greatly diverse conditions. The study will provide laboratory measurements of directional reflectance spectra from .3 to 3.5 micrometers from near normal to 100 deg phase. The ultimate goal is to approach a comprehensive understanding of the interaction of light with a particulate surface.

W80-70539 **153-02-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PETROLOGY LAB
A. Finnerty 213-354-4785

Investigations being conducted in planetary petrology are supported through experiments on model compositions, terrestrial rocks, meteorites and lunar rocks, and thermodynamic theory. The investigations will interface with ongoing studies in the planetology area to provide petrological constraints. Research will be conducted to define creep behavior of water ice as a function of stress over temperature ranging from liquid nitrogen to the ice melting point. This information will be used to predict the form, evolution, and lifetime of major surface features on icy Galilean satellites.

W80-70540 **153-03-42**
Lyndon B. Johnson Space Center, Houston, Tex.
THEORETICAL STUDIES OF PLANETARY INTERIORS
W. C. Phinney 713-483-3816

The objective is to provide further models of planetary - scale chemical differentiation, outgassing of atmospheres, and petrogenesis. The study will utilize the temperature and mass transport outputs from global thermal models to determine the effects on partial melting and migration of melts.

W80-70541 **153-03-72**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY INTERIORS
R. J. Phillips 213-354-4973

A series of investigations on interrelated tasks will be carried out in relation to the evolution and present state of the interiors of the terrestrial planets. Included will be investigations of: (1) effects of temperature-dependent viscosity on planetary convection; (2) relationship of surface topographic stress to convection planform; (3) origin of long-wavelength gravity anomalies; (4) the origin, evolution, and present state of the thermal events associated with the Tharsis region of Mars; (5) viscoelastic convection; (6) certain geophysical problems associated with the Galilean satellites; and (7) planetary thermal modeling with finite difference programs.

W80-70542 **153-03-73**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOLAR NEBULA FORMATION AND PLANETARY INTERIORS
M. Kobrick 213-354-6614

Two activities are covered: (1) solar nebula formation calculations; and (2) studies of planetary isostatic equilibrium. The objective of the solar nebula formation task is to gain an understanding of the dynamical effects of neighboring protostellar fragments in a collapsing cloud on the evolution of an individual protostar and on the formation of an associated protoplanetary nebula. In addition, fragmentation modes of a collapsing nebula will be investigated and an evaluation made of the importance of the various parameters in determining stability. For the global isostasy task the aim is to determine the mode and extent of isostatic support of large topographic features on the Earth, Moon and Mars in order to further elucidate their thermal and tectonic histories. The approach to the solar nebula problem involves the use of a Lagrangian point particle algorithm to simulate the collapse and evolution of a protostellar Cloud. The simulation will be used for: (1) test and verification of the Lagrangian technique; (2) evaluation of tidal effects; (3) study of stability and fragmentation modes; and (4) evaluation of the physical conditions within the collapsing nebula. The global isostasy task will involve the construction of planetary isostatic models that encompass the classical Airy and Pratt calculations as well as more general linear models, and a statistical analysis of the topographic and gravitational potential data for the Earth, Moon and Mars.

W80-70543 **153-04-61**
Ames Research Center, Moffett Field, Calif.
LUNAR INTERIOR AND MAGNETOSPHERE
P. Dyal 415-965-5523

The objective is to study the lunar interior and crust. Mathematical models, magnetic field data, solar wind data, and photographic measurements will be used to examine these geophysical aspects of the Moon. A proposal titled Physical Properties of the Moon from Synthesis of Magnetometer Data by P. Dyal was submitted, reviewed, and funded in FY-79. A new proposal will be submitted in this research area for FY-80. The magnetic field data obtained in the Apollo program will be used to study the internal lunar conductivity, permeability, and to investigate the properties of the crustal remanent fields. From these studies the internal temperature, iron abundance, and the topology and history of the crustal magnetic units will be determined. Data from the following instruments will be used: the Apollo 12, 14, 15, 16 and Lunokhod 2 lunar surface and lunar portable magnetometers, the Apollo 15, 16, Lunar 22 and Explorer 35 lunar orbiting satellite magnetometers, and the Apollo 12 and 15 solar wind spectrometers. The results of these tasks will be submitted for publication in scientific journals.

W80-70544 **153-04-72**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY MAGNETISM AND PLASMA INTERACTIONS
B. E. Goldstein 213-354-7589

The basic objectives are: (1) to better determine lunar interior temperature and composition by estimating the interior electrical conductivity of the Moon, and (2) to understand how the electrical conductivity of the interior of Mercury and induced magnetic fields in the planetary interior affect the planetary interaction with the solar wind and alter the atmospheric supply rate. The approaches are: (1) to conduct theoretical studies of electromagnetic induction in the lunar interior with appropriate boundary conditions for a variety of lunar electrical conductivity models, (2) to use lunar magnetometer and plasma data to determine the strength of induced lunar magnetic fields and estimate the interior conductivity by comparison to the theoretical models, and (3) for Mercury, calculate how magnetic fields induced in the planetary interior affect the magnetospheric field strength, the solar wind stand-off distance, and particle fluxes to the planetary surface. As the emphasis of the work on Mercury has been shifting towards atmospheres it is planned to discontinue work on this project under the Planetary Geophysics and Geochemistry program at the end of FY-79.

W80-70545 **153-05-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY DYNAMICS
W. R. Ward 213-792-6538

This is a multifaceted program targeted at improving our understanding of solar system formation and dynamical evolution. The tasks can be grouped into four broad categories: (1) solar system formation in which both solid and gaseous accretion mechanisms will be studied. In the former, planetesimal interactions driven by the nebula (viz., resonance stirring) will be among the processes scrutinized; in the latter the nebular conditions that will initiate gas accretion onto a rocky planetary core will be ascertained. Vortex motion leading to the loss of angular momentum in interstellar nebulae and molecular clouds will be analyzed and conditions of vortex breakdown and gravitational collapse determined. Finally, constraints on the solar nebula dispersal mechanisms and time scales will be sought by modeling the dynamical response of the newly formed planetary system to that event. (2) the evolution of long-period comets under a combination of planetary and stellar perturbations and physical loss mechanisms will be modeled in an effort to test competing theories of cometary origin. Improvement in the accuracy of selected asteroid orbit determinations can be accomplished via the Palomar Schmidt plate collection. Further asteroid theoretical efforts will center around secular and orbit-orbit resonances and their role in shaping asteroid belt morphology. Mass determination of principal asteroids can be made from a combination of Earth-based radar, Mariner 9 and Viking range residual data. (3) Saturn's rings in which research proceeds with continued analysis of two Iapetus eclipses by the rings in order to determine a radial transmission profile. Also the photometry of density waves will be studied, this phenomena being suggested as a cause of the azimuthal brightness variations of the A ring. A model for the dynamical evolution of the ring system including viscous stresses, gravitational scattering and instabilities is being developed to test possible ideas of ring origin. (4) Planetary rotations in which gravity measurements from Pioneer Venus will indirectly determine the planet's damped pole position and could also detect a finite wobble thus providing a need for renewed theoretical efforts. One area of concentration will be the coupling mechanism between a fluid core and solid mantle, with possible applications to Mercury and the moon as well.

W80-70546 **153-06-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY SYNTHESIS
W. C. Phinney 713-483-3816

Physical and chemical constraints on the origin and evolution of the solid objects of the solar system are being investigated. Spectroscopic techniques are being applied over a broad range of the electromagnetic spectrum to probe the chemistry, mineralogy, and structure of planetary surfaces and serve as constraints of evolutionary models. Remote sensing phenomena currently under study include gamma ray emission, X-ray emission, and reflection of solar radiation. Petrologic and tectonic studies and models of the evolution of planetary crusts are underway with a strong basis in lunar and terrestrial data. Activities include laboratory experiments, Earth-based telescopic observations, instrument development, X-ray gamma ray data from lunar orbiters, and laboratory analyses of terrestrial materials.

W80-70547 **153-06-50**
Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF THE SOVIET MARS 4, MARS 5 AND VENERA DATA
J. I. Trombka 301-344-5941

We have been asked by the Soviet Academy of Sciences to analyze their gamma-ray spectrometer data obtained on Mars 4, Mars 5 and Venera. We have developed methods for the analysis of such data as a result of our work during Apollo and Apollo-Soyuz missions. It is these methods that we will use to perform the analysis. We have received some preliminary data from the Soviet experimentors at the Vernadsky Institute. Analysis performed using the analytical system developed at GSFC indicate that the method will work. The Soviet experimentors are willing to send us a more complete data set. This information is required for the analysis. As part of this cooperative program, thick target measurements using high energy protons beams on materials of interest in the study of condensed matter will be carried out. A common experiment design will be determined between Soviet and U.S. experimentors. High energy protons beams available in both countries can then be used for the measurements and the results can be correlated. A catalogue of the results obtained will then be accumulated. This catalogue will be very important for the interpretation of discrete gamma ray line emission measured during a number of future space flight missions.

W80-70548 **153-06-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY SYNTHESIS
D. L. Matson 213-354-2984

This RTOP consists of six tasks in the area of comparative planetology of satellites, geochemical mapping, surface properties, lunar multispectral imaging, ground-based microwave mapping, and Venera 8, 9, and 10 geochemical experiments.

W80-70549 **153-07-40**
Lyndon B. Johnson Space Center, Houston, Tex.
REMOTE SENSING
W. C. Phinney 713-483-3816

A laboratory program based on infrared interferometry of particulate materials will define the spectral radiative transfer regime in planetary surfaces. A concurrent program of telescopic observations will yield data which can be interpreted in terms

of the experimental work and which can be compared to results from other techniques.

W80-70550 **153-07-60**
Ames Research Center, Moffett Field, Calif.
INFRARED FEATURES OF PLANETS AND SATELLITES
E. F. Erickson 415-965-5508

The objective of the work proposed here is to improve our understanding of the composition and physical characteristics of materials on planets and satellites. The approach is to obtain, analyze, and interpret infrared spectrophotometric measurements; the interpretation phase of this process consists of calculating theoretical synthetic spectra to compare with the observations. Data to be used in this study are obtained from above the earth's tropopause, and are therefore largely free from telluric contamination. The data are sensitive to mineral, aerosol, and gaseous spectral signatures which may appear in emission or absorption.

W80-70551 **153-07-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADAR STUDIES
C. Elachi 213-354-5673

The objectives are: (1) develop a data base for the interpretation of radar data of planetary surfaces which will be obtained with an orbiting sensor; specific mission in mind is the VOIR 84; (2) develop the techniques to interpret these data; (3) get the planetary sciences community familiar with the interpretation of radar images; and (4) develop an Imaging Radar Data Center at JPL in support of the above activities. The data base will consist of: A/C, Seasat-A and SIR-A radar images, Landsat images, geologic maps, and ground images. These data will be obtained for a wide variety of representative test sites.

W80-70552 **153-08-60**
Ames Research Center, Moffett Field, Calif.
NASA AMES RESEARCH CENTER VERTICAL GUN FACILITY
O. L. Koontz 415-965-5526

The Ames Research Center Vertical Gun Range is a ballistic facility used to simulate and study the physics and mechanics of planetary impact cratering phenomenon. Ballistic technologies, utilizing light gas and gun powder, enable acceleration of projectiles up to 2 centimeters diameter at relative velocities of approximately 8 km/sec. By varying the gun's angle of elevation with respect to the target vacuum tank, impact angles from 0 deg to 90 deg with respect to the gravitational vector are possible. In conjunction with the Lunar and Planetary Institute, Ames Research Center (ARC) will operate the Ames Vertical Gun Facility as a national facility. ARC's responsibility is to manage the Vertical Gun Facility operations, including manpower, expendables, targets, etc.; maintain equipment and provide for facility modification and upgrading, as needed. ARC proposes to operate the facility in such a manner as to provide maximum support to the scientific community in the studying and understanding of impact processes in planetary formation and modification.

W80-70553 **153-09-50**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY, GAMMA-RAY AND NEUTRON-GAMMA-RAY METHODS FOR PLANETARY EXPLORATION
J. I. Trombka 301-344-5941

The objective of this investigation is to develop instrumental systems and obtain cross sections for remote measurements of the spectra of X-ray, gamma ray, and neutron-gamma ray emission from planetary bodies. Specific emphasis will be placed on those studies relevant to a cometary space flight mission. These measurements will be used to obtain geochemical and geophysical information concerning such planetary bodies.

W80-70554 **153-09-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INSTRUMENT DEFINITION
A. E. Metzger 213-354-4017

This RTOP contains the following five tasks: (1) advanced gamma ray spectroscopy, (2) alpha/X-Ray analysis using solid state detectors, (3) construction of an electron miniprobe phototype for the analysis of cometary dust, (4) X-Ray spectroscopy of the outer planet satellites, and (5) relative speed measuring system for planetary gravity mapping. The general objective of this program is the timely development of instruments for experiments to support the proposed Comet Halley/Tempel and Saturn Orbiter-Probe missions. Specifically the tasks are: (1) to continue scientific studies and undertake the engineering development of a gamma ray spectrometer with which to characterize the chemistry of a comet nucleus and to chemically map the surface of planetary bodies from orbit, (2) to develop an instrument to provide a combined alpha-scattering, alpha-proton reaction and high resolution X-ray analysis of cometary dust, (3) generate a study/bread-board to establish and demonstrate the feasibility of adapting electron prove X-ray microanalysis to the imaging and analysis of cometary dust and condensates found in the solar nebula, (4) demonstrate by analysis and experiment the feasibility of designing an X-ray spectroscopy instrument to determine the surface chemistry of Galilean and Saturnian satellites which are immersed in the magnetospheric particle fluxes of the parent planets, and (5) develop and verify a spaceborne system to determine relative velocity between the spacecraft and the planetary surface for gravity mapping application.

W80-70555 **153-10-40**
Lyndon B. Johnson Space Center, Houston, Tex.
JSC GENERAL OPERATIONS - GEOPHYSICS AND GEOCHEMISTRY
M. B. Duke 713-483-4464

General operations support a variety of institutional and scientific support tasks at JSC that are considered essential for the conduct of research and for implementation of the planetary geophysics and geochemistry program. Center support services such as printing, computer, photographic, and graphics are provided through a procedural agreement with the Lunar and Planetary Institute. In-house support provides for co-sponsorship of conferences, laboratory costs required by visiting scientists using existing facilities, and for costs required to operate common laboratory facilities and to provide for support services from other center elements.

Planetary Atmospheres

W80-70556 **154-10-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERIC COMPOSITION AND STRUCTURE
J. B. Pollack 415-965-5530

Theoretical modeling and spacecraft data interpretation are used to determine the properties and physical processes characteristic of planetary atmospheres. These properties include their temperature structure, aerosols, cloud layers, gaseous constituents, and opacity sources. Emphasis is placed on reducing and analyzing data returned from spacecraft missions, such as Pioneer Venus, or preparing for data expected from future spacecraft missions, such as Voyager. However, use is also made of relevant ground-based observations. Tasks relevant to Pioneer Venus include data analysis of results from the large probe Infrared Radiometer, Atmospheric Structure, and Gas Chromatography experiments. Other tasks are directed at investigating the properties of Titan's atmosphere and the rings of Saturn. Such Investigations are relevant for both the upcoming Voyager mission through the Saturn system and the contemplated SOP(2) mission.

W80-70557 **154-10-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY ATMOSPHERES COMPOSITION AND STRUCTURE
J. T. Bergstralh 213-354-2517

Two tasks are reported. Task one, Pioneer data analysis on the atmosphere of Jupiter, covers analyses of Jovian photopolari-

metric (IPP) and radiometric (IRR) data from the Pioneer 10 and 11 spacecraft. Spacecraft data, in conjunction with ground-based observations made near the times of the Pioneer Jupiter encounters, are used to constrain realistic models of Jupiter's lower stratosphere and upper troposphere. Task two, outer-Planet atmospheric equilibrium models, will determine the processes by which energy is deposited in and removed from the upper tropospheres and stratospheres of the outer planets using quantitative equilibrium models for these processes. The results of this work will constitute a major part of the foundation for developing predictive models of these atmospheres. The latter must be consistent with available chemical and cloud structure information, and the energetic processes predicted by them must reproduce the thermal structures observed in the outer planets' atmospheres, including observed variations with space and time. Early results are expected to include a determination of heating/cooling rates required to maintain the observed Jovian atmospheric structure from computation of the infrared flux divergence associated with the chemical composition and thermal structure.

W80-70558 **154-20-80**
Ames Research Center, Moffett Field, Calif.
DYNAMICS OF PLANETARY ATMOSPHERES
R. E. Young 415-965-5515

The dynamics of the atmosphere of Venus is being studied using a 3-dimensional circulation model. The fully coupled nonlinear momentum and energy equations are solved numerically using a combination of finite differences and spectral methods. The principal goals are to understand the dynamical effects of varying planetary rotation rate, solar energy deposition, infrared opacity, atmospheric mass and composition.

W80-70559 **154-20-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DYNAMICS
R. W. Zurek 213-354-4223
(385-36-01)

The first objective proposed is to understand in general the spectacular planetary-scale evolution of Martian global dust storms and to demonstrate in particular whether or not the dynamic-radiative interaction in the dusty Martian atmosphere is the physical mechanism which controls this evolution. The basic approach is to compute radiative equilibrium temperature profiles for specified dust distributions. The resulting temperature fields will provide the basic state thermal fields needed to study the short-period evolution of the circulation and dust distribution using a quasi-geostrophic circulation model. The solar heating and infrared radiation fields due to airborne dust will be computed using a previously developed delta-Eddington radiation code. The second objective proposed is to analyze the radio scattering effects observed during the radio occultation measurements of various planetary missions so that they can be developed into a tool for studying turbulence in planetary atmospheres, electron density irregularities in planetary ionospheres, and the magnetic field in the ionospheres of magnetic planets and their satellites. Demonstration and application of these remote sensing techniques are important because they provide information that is otherwise unavailable. This information will in turn lead to a better understanding of the dynamics of planetary atmospheres, and of the electron density irregularities and the magnetic field in planetary ionospheres.

W80-70560 **154-20-80**
Goddard Space Flight Center, Greenbelt, Md.
DYNAMICS OF PLANETARY ATMOSPHERES
J. A. Pirraglia 301-344-6783

Planetary missions supplemented by ground based and airborne instruments have greatly increased our knowledge of the atmospheres of Jupiter, Venus, and Mars and planned missions promise more detailed information on Jupiter, Saturn, and their satellites. The planets and their satellites present contrasts in mass, rotation rates, radiative time constants, heat deposition and topographic influence of the atmosphere and for a better understanding of these disparate atmospheres it is necessary to develop a general approach to theoretical atmospheric atmospheric dynamics based upon the existing data obtained from the planetary missions. The widely differing conditions permit the isolation of specific phenomena and allow comparisons of different regions of the parameter space associated with a particular phenomenon. An investigation of atmospheric circulation with momentum transport shows that the circulation is strongly affected by the transport terms. The relationship between the mean flow and the waves that contribute to the momentum transport will be investigated from both the points of view of wave instabilities and wave-mean flow interaction. Momentum transport models will be used to compare the circulation of the various planets and to assess the models.

W80-70561 **154-30-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CLOUDS, PARTICULATES AND ICES
C. Elachi 213-354-5673

The two activities discussed include: (1) Venus cloud properties, and (2) infrared emission from cometary dust. The objective of the Venus cloud study is to understand the condensation properties of the clouds, their liquid content, the growth of cloud droplets, the possibility of precipitation and its properties, and the possibility of lightning and its properties. The objective of the cometary dust study is to compute the thermal emission of cometary dust grains as a function of particle size, wavelength and heliocentric distance, based on measured refractive indices for ice, silicates, and absorbing materials. These models will be compared with observations of infrared cometary emission, in order to derive the composition and dominant size range of the dust being emitted from specific comets, and will be applied to predicting dust emission characteristics for comets Halley and Tempel 2, the targets for the proposed cometary mission. The approach for the study of the clouds of Venus is to use Mariner 10 and Pioneer radio occultation data and Pioneer probe data to derive the liquid content of the clouds. The growth and electric charging properties would then be derived using models developed for the study of Earth clouds with the appropriate modifications.

W80-70562 **154-30-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY CLOUDS, PARTICULATES AND ICES
R. C. Whitten 415-965-5498
(154-75-80; 154-10-80; 198-30-02)

A model of the Venus clouds, which simulates gas phase sulfur chemistry and the height and size distribution of the cloud particles, has been constructed. Possible chemical reaction sequences are now being studied for the purpose of finding one or more that will, when simulated in the model, yield predictions that agree with Pioneer Venus observations of cloud structure and composition, and atmospheric composition. The models of the Venus clouds together with a dynamical model of the circulation of the Venus atmosphere will be used to study those characteristic interactions between radiation and atmospheric motions that may cause the observed ultraviolet features. Observational data on the Venus cloud layer will be analyzed and interpreted in terms of particle size distribution, height distribution, and composition.

W80-70563 **154-30-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CLOUD PHYSICS AND VERTICAL STRUCTURE FROM VOYAGER DATA
R. J. Terrile 213-354-2140

The object of this program is to use the Voyager imaging and infrared interferometer spectrometer (IRIS) data to determine a number of physical parameters for the Jovian, and eventually Saturnian, clouds. These data will be combined with high resolution ground-based 5 microns images to discern the vertical scale between interacting dynamical regimes in the cloud layers. This study will concentrate on the following aspects: (1) categorization of Jovian cloud images in terms of gross morphology and possible terrestrial analogs; (2) use of Voyager data to map 'cloud stratigraphy' by finding features which clearly overlie, overlap or transect lower cloud structures, and use ground-based 5 microns data to interpret cloud heights directly from brightness tempera-

tures; (3) use imaging and 5 microns data to determine the vertical wind shear in the equatorial zone; (4) combine Voyager imaging, IRIS and 5 microns mapping to constrain chromophore models for the coloring agents of the Jovian clouds; (5) use IRIS, imaging and 5 microns data to measure the upper atmosphere temperature structure in relation to the lower cloud opacities; and (6) combine dynamical data with morphology and stratigraphy to characterize fully regimes of activity in the Jovian atmosphere. These analyses rely heavily on the powerful image processing techniques available at JPL and also on the interfacing of the Voyager Imaging and IRIS teams with the available data sets.

W80-70564 **154-40-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADIATIVE TRANSFER
M. Chahine 213-354-2433

The objective of this research is the development and application of numerical techniques for the interpretation of remote sensing data obtained under realistic cloudy conditions. Studies will be conducted to: (1) develop an analytical approach for uncoupling the thermal emission of the clear and cloudy portions of the field of view of an observing system; (2) develop and apply numerical method for the determination of the radiative transfer properties of clouds for Venus, Jupiter and Saturn; (3) formulate an approach for the determination of gaseous mixing ratios and composition profiles from measurements obtained in the presence of clouds; (4) apply these results to the study of information content of multiple scattering from model Jupiter and Saturn clouds of such particles; and (5) apply these results to the analysis of the Jovian thermal sounding problem. By treating the cloud effects on the clear-column radiance as short term oscillations it is possible to uncouple the radiative effects of clouds from the radiative effects of gaseous absorbers. Once the clear-column temperature profiles are determined the same radiance data could then be used to determine the heights, amounts, and radiative transfer properties of clouds and hazes.

W80-70565 **154-50-80**
Goddard Space Flight Center, Greenbelt, Md.
ATOMIC & MOLECULAR PROPERTIES OF PLANETARY ATMOSPHERIC CONSTITUENTS
J. J. Hillman 301-344-8431
(196-41-54; 198-10-01; 196-41-50; 188-41-55)

The principal goal of this molecular spectroscopy program is to develop an organized, solid body of knowledge of the molecular properties of planetary atmospheric constituents. The objectives leading to the overall goal of this program are to provide the required ultra-high resolution infrared spectroscopy, and to create the necessary theoretical foundations, to correctly interpret the infrared measurements of the outer planets. The approaches to be taken include: Doppler-limited laboratory spectroscopy of planetary constituents in the middle infrared (600-2000/cm); the theoretical development of a, pressure-induced absorption model, resulting from H2-H2 and H2-He collisions, which accurately characterizes the opacity of the outer planet atmospheres in the far infrared region (10-2000/cm); development of molecular models for the infrared active bands of ammonia (950-3600/cm). Spectral parameters generated with these models will then be compiled into atlas form for future use of all planetary researchers.

W80-70566 **154-50-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ATOMIC AND MOLECULAR PROPERTIES
M. Geller 213-354-2593
(154-20-80; 154-40-80)

A broad program of experimental and theoretical studies pertaining to planetary atmospheres will be conducted with the following primary objectives: (1) understanding the properties and determination of the parameters of the constituents of planetary atmospheres; (2) application of experimental data (laboratory, astronomical and spacecraft) to the understanding and interpretation of spectral features of complex planetary atmospheres; and (3) applying these findings toward design of ground based and spacecraft experimental concepts. The studies to be conducted in FY-80 pertain to the determination of millimeter and submillimeter spectra, theoretical spectroscopic development, and a continuing collaborative effort with Dr. G. Birnbaum of the National Bureau of Standards on long path, multithermal measurements of the opacity of major constituents of planetary atmospheres, specifically, the opacity of NH3 both in the far infrared and near five microns.

W80-70567 **154-60-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AERONOMY: THEORY AND ANALYSIS
W. T. Huntress 213-354-2140
(154-75-80)

The overall objective of the aeronomy theory and analysis program is to address fundamental physical and chemical processes in planetary atmospheres and in comets. The emphasis is on understanding the photochemistry, ion-chemistry, nonthermal processes and dynamics in planetary atmospheres and comets. Models are constructed of atmospheric composition and structure for comparison with spacecraft measurements, and for mission planning. Laboratory data on photochemical and ion-molecule reactions, and ground based or spacecraft remote sensing and in-situ data, are used to construct the models. The objective of the comet work is to provide a radial 1-D chemical model of the comae of Halley and Tempel 2 based on the comet SWG gas production models, a composition based on condensation of interstellar material, and laboratory work in a related RTOP on comet chemistry. The extensive chemical evolution code of S. S. Prasad (JPL) will be used in collaboration with G. F. Mitchell (St. Mary's University).

W80-70568 **154-60-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY AERONOMY: THEORY AND ANALYSIS
R. E. Hartle 301-344-8234

The basic objective is to study the observed properties of the neutral atmospheres and ionospheres of the planets and their satellites, including earth, in order to identify and interpret the physical and chemical processes governing their behavior, encompassing solar planetary relationships. The motivating philosophy here is that the study of processes occurring in the atmospheres and ionospheres of the planets and their satellites provides important insights into the nature of similar processes operative in the earth's atmosphere and ionosphere under different parametric conditions and vice versa. These investigations are pursued by analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated. The data are used to determine the various chemical, compositional, dynamical and energetic states of the respective atmospheres and ionospheres, including the transport and deposition of mass, momentum and energy in these regimes. In general, the approach involves the development of empirical descriptions of either global or small scale phenomena using data sets from a variety of spacecraft. These empirical descriptions of the atmospheres and ionospheres are subsequently interpreted using theoretical models developed to deduce the physical and chemical processes involved. Some of the specific phenomena addressed in this investigation include: atmospheric and ionospheric motions in Venus and earth; interaction of solar wind and/or magnetosphere with atmosphere of Venus and Earth, including modification of transport coefficients by plasma instabilities; solar planetary relationships, comparative planetary atmospheres, etc.

W80-70569 **154-70-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AERONOMY: ENERGY DEPOSITION
S. Trajmar 213-354-2145

Electron impact excitation and ionization of species which are important in planetary environments (with major emphasis on the Jupiter environment) will be studied. Cross sections for these processes and photon emissions following these impact excitations will be measured. The species will include both neutral atoms (He, Ne, Ar, Kr, Na, K, S, Mg, Ca) and molecules (H2, CO, H2O, CO2, CH4, NH3) as well as ions (SII, SIII, OII, OIII). The measurements will be carried out utilizing spectrometers and techniques developed in our laboratories. The results will

be made available to researchers involved in planetary observations and modeling. Effort will be made to correlate the laboratory work with modeling needs as they develop and to help the interpretation of optical observations as well as the planning of future observations.

W80-70570 **154-70-80**
Goddard Space Flight Center, Greenbelt, Md.
ULTRAVIOLET SPECTROSCOPY OF PLANETARY ATOMS AND MOLECULES
L. J. Stief 301-344-7529

The objectives are to measure the optical properties of atoms, free radicals and molecules which are important in understanding the composition of planetary atmospheres and comets. Emphasis is placed on those problems which are of immediate concern for interpreting the results of rocket, satellite and planetary probe observations. Several types of spectroscopic measurements are made. First, photoabsorption and photoionization cross sections are measured. Cross sections are also determined for producing ion or atomic fragments in given excited electronic states. Branching ratios are measured for excited states which radiate in lower level excited states via photon emission. Electron impact excitation cross sections are determined.

W80-70571 **154-75-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AERONOMY: CHEMISTRY
W. T. Huntress 213-354-2140

The objective is to investigate the chemistry of planetary atmospheres and cometary comae. The major emphasis is on the photochemical and ion chemical regions of planetary atmospheres and comets. Laboratory work on ion-molecule reactions is the primary work unit, so that the principal goal at present is an understanding of planetary and comet ionospheric chemistry. The principal planets presently under study are Venus, Jupiter, Saturn and Titan. The principal comets are Halley and Tempel 2. The laboratory data being generated is made available for use in constructing models of the ion chemistry of these bodies. Laboratory work is also directed toward the origin of organic species in the atmospheres of the outer planets and Titan.

W80-70572 **154-75-80**
Ames Research Center, Moffett Field, Calif.
AERONOMY OF PLANETARY ATMOSPHERES: CHEMISTRY
R. C. Whitten 415-965-5498
(154-30-80; 198-30-02; 154-10-80)

Theoretical modeling is used to determine the chemical properties of the atmospheres of Mars, Venus, and Titan. The seasonal variation of ozone on Mars is being explained in terms of hydrogen-oxygen chemistry and reactions on the planet's surface. Model studies of the aeronomy of O2 in the Venus atmosphere seek to explain the high abundance observed by Pioneer Venus, particularly as it is related to sulfur chemistry. Model studies of the Titan atmosphere will lead to estimates of the formation rate and abundance of hydrocarbon-aminos due to charged particle reactions caused by cosmic rays or trapped particles. Laboratory studies of chemical processes important to the structure of planetary atmospheres are in progress. Examples of these processes are the three body reaction of chlorine with H2 to produce HCl, the photolysis of methane by Lyman alpha, the photolysis of carbonyl sulfide, and sulfur oxidation reactions which may be important in the Venus atmosphere.

W80-70573 **154-80-80**
Goddard Space Flight Center, Greenbelt, Md.
EXTENDED ATMOSPHERES
H. A. Taylor 301-344-6610

The objective is to advance the understanding of solar-planetary relationships using the evidence of the global characteristics of ionosphere-neutral atmosphere variations as indicators of coupling processes regulating the upper atmosphere in the region extending from the exobase to the ionopause. By examining the behavior of the ionic constituents at lower altitudes near the exobase and at higher altitudes approaching the ionopause, insight is obtained with respect to collision dominated as well as collisionless processes. Such studies relate to longer term effects such as the basic planetary atmosphere evolution as well as short term effects such as the ionospheric response to solar wind variability. The approach involves the examination and description of global data sets of satellite and ground-based data relevant to the composition, structure, and energetic states of the planetary atmosphere-ionosphere system. These descriptions include large scale results in the form of empirical models as well as phenomenological data sets descriptive of uniquely varying conditions or events. Results of the empirical studies are assessed in terms of current theoretical models. Comparison of model results for contrasting planetary conditions, e.g. Earth and Venus, provides a basis for testing basic physical concepts.

W80-70574 **154-80-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY ATMOSPHERES AND SPACE PLASMA INTERACTIONS
B. E. Goldstein 213-354-7589

The general objective of this task is to better understand the interaction of planetary atmospheres with the solar wind. The solar wind can influence planetary atmospheres either directly by impact on the ionosphere or the planetary surface, or indirectly via magnetospheric processes. The solar wind can be the dominant source of a collisionless atmosphere, can significantly heat and ionize the outer ionospheres of planets and comets, and provides the basic energy source for convection in the magnetospheres of terrestrial planets. The approach of this task will be to conduct theoretical and computational studies of particular atmosphere-plasma interaction topics; data analyses may in some cases be conducted. During the current fiscal year the effort will be directed towards determining solar wind source rates for the atmosphere of Mercury by direct impact on the surface, through the polar cusps, and by precipitation from the plasma sheet.

W80-70575 **154-90-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY ATMOSPHERE EXPERIMENT DEVELOPMENT
H. B. Niemann 301-344-8706

The objective is to develop instrumentation and necessary specialized test and calibration techniques for in-situ neutral gas and ion composition and density measurements in planetary atmospheres. The instrument development is focussed on neutral gas and ion mass spectrometry. Different atmospheric environment encountered in various planetary missions as well as the different scientific goals set for the studies of the planets require instrument performance which are highly mission specific. Work will be done in five areas: (1) mass spectrometer sensor development - ion source efficiencies will be optimized for operation in high particle velocity regimes (greater than or equal to 50km/sec), high pressure ion source and large dynamic range analyzer systems will be developed for trace gas detection; (2) sample inlet systems - compact gas leaks for pressure reduction from high pressure atmosphere to ion source operating levels and sample enrichment techniques for trace gas analysis will be developed; (3) calibration and test equipment - intermediate velocity molecular and atomic beam systems and trace gas mixing systems will be developed to simulate expected planetary and cometary atmosphere conditions for evaluation of instrument performance and calibration; (4) electronics system - advanced digital logic and analog control circuits for onboard data processing using micro processor and hybrid electronics packaging techniques will be developed; and (5) auxiliary system - light weight vacuum pumps for application in high pressure atmosphere on planetary entry probes will be developed.

W80-70576 **154-90-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ATMOSPHERIC EXPERIMENT DEVELOPMENT
D. J. McCleese 213-354-2317

The objective is to contribute to NASA's program of planetary exploration by evolving new or improved experiments for the investigations of the atmospheres of the planets by measurements from spacecraft. The emphasis is on remote sensing observations from orbiter or flyby missions using infrared techniques. The

approach is by a process of evolution from a detailed definition of the problem, through identification of a useful and feasible experimental approach, computerized numerical studies of expected performance and optimization of the instrument concept, to the development in the laboratory of brassboard hardware and, finally, flight experiments. The tools employed in this are sophisticated numerical methods for radiative transfer and for fluid dynamics in planetary atmospheres, remote sensing and data inversion techniques, realistic and up-to-date atmospheric models, research into the spectral properties of planetary atmospheric gases and cloud constituents, and expertise in the design, fabrication and testing of state-of-the art infrared instruments for spacecraft.

W80-70577 **154-90-80**
Ames Research Center, Moffett Field, Calif.
SUPPORTING RESEARCH FOR ATMOSPHERE STRUCTURE, MEASUREMENTS BY USE OF PLANETARY ENTRY PROBES
A. Seiff 415-965-5685
(154-10-80; 154-20-80)

This RTOP provides laboratory, field test, and theoretical support for ongoing and future experiments to define the structure of the atmospheres of Venus and Jupiter and other outer planets and satellites. The RTOP objectives are typically outside the scope of project activity, but answer key questions relative to experiment interpretation, limitations, and extensions in capability. Key objectives for FY-80 are: to study the phenomenon of electrostatic charge buildup on probes descending in dense atmospheres, and their effects on probe instruments (This has possible relevance to the mysterious malfunctions encountered in the lower Venus atmosphere by the Pioneer probes, and could reoccur, if not fully understood and corrected, in the Galileo probe descent on Jupiter); to study chemical interactions between probe materials and carbon-dioxide, nitrogen, and hydrogen atmospheres; and to study temperature sensor interactions with clouds composed of water, ammonia, ammonium hydroxide, ammonium sulfide, and sulfuric acid. The approach is to perform laboratory experiments and flight experiments. Flight experiments involve drop tests of simple probe models in the earth's atmosphere. The activity is manpower limited, so that all desirable objectives identified cannot be fully responded to.

W80-70578 **154-91-80**
Goddard Space Flight Center, Greenbelt, Md.
DUST AVOIDANCE TECHNIQUES FOR NEUTRAL AND ION MASS SPECTROMETERS ON COMETARY PROBES
H. B. Niemann 301-344-8706

The objective of this work is to investigate, develop, and test practical methods for conducting direct measurements of neutral and ion composition in the immediate vicinity of comets. The dust component of the cometary environment constitutes a hostile parameter impacting direct measurement techniques. Within the scope of the proposed effort, the physical characteristics of the anticipated dust environment will be reviewed, and conceptual approaches for avoiding the dust contamination problem will be analyzed and modelled. A laboratory test model incorporating the more promising features of the analytical study will be constructed and tested under simulated conditions in the laboratory. These tests will include the generation of a test beam of dust particles, and the use of ion and neutral particle detectors in a diagnostic survey of the flow trajectories and density distributions of both accepted and rejected particles. The work shall be performed under the technical direction of lead scientists at the Goddard Space Flight Center and with the technical support of associated industrial and university research groups.

Mars Data Analysis

W80-70579 **155-20-40**
Lyndon B. Johnson Space Center, Houston, Tex.
MARS DATA ANALYSIS STUDIES
W. C. Phinney 713-483-3816

The objective of these studies is to provide data on the physical and chemical processes which could have produced rocks and soils on Mars. These data should provide a basis for interpretation of the existing remote chemical, physical, and geological data from Mars, particularly those provided by the Viking Mission. The studies will use a variety of theoretical, experimental, analytical, and analog techniques to obtain these data. The approach will be to use the technique of experimental and theoretical petrology to provide data on melting relations and petrogenesis, to use geochemical modelling techniques to constrain the evolution of rock and soil systems, to use experimental simulations to quantify the effects of weathering the properties of rocks, soils, and minerals, and to use terrestrial analogs of Martian surface structures to help constrain evolutionary models of Mars's crust. A wide range of analytical techniques will be used to characterize the physical and chemical properties of materials.

W80-70580 **155-20-50**
Goddard Space Flight Center, Greenbelt, Md.
INTERPRETATION OF ORBITAL GAMMA-RAY SPECTROMETER DATA UTILIZING VIKING SURFACE ELEMENTAL COMPOSITION MEASUREMENTS
J. I. Trombka 301-344-5941

The objective of this proposed research is to make use of the Viking measurements of the composition of the Martian atmosphere and surface in order to understand and extract global geochemical information from orbital gamma ray spectrometer data. Because of our collaboration with the Soviet experimenters, we think that this proposal presents a unique opportunity to combine the results of the Viking surface measurements with the Mars 5 orbital gamma ray measurements. This research will also set baseline data for the planning of future orbital geochemical mapping experiments for Mars. We will use the methods developed for the Apollo X-ray spectrometer to analyze the Viking gamma ray fluorescent experimentation in cooperation with the other principal investigators. This work is a result of our submission and selection as principal investigator on the Mars Data Analysis Program.

W80-70581 **155-20-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARS DATA ANALYSIS STUDIES
F. D. Palluconi 213-354-5867

The proposal for Mars Data Analysis Studies consists of ten tasks to be carried out in FY-80. Tasks are being performed in a variety of disciplines, including topography, gravity, regolith adsorption, and thermophysical properties of the Martian surface.

W80-70582 **155-41-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARS DATA ANALYSIS - ASTRONOMY
R. A. Preston 213-354-6895
(155-20-70)

Radio tracking of the Viking Mars mission orbiters and landers have provided a wealth of radio science data. Much of this data remains to be analyzed. Viking Lander radio data continues to be transmitted and provides an opportunity for additional scientific return. Plans are: (1) continue the acquisition of Lander Doppler and range data in support of radio science investigation both here at JPL and elsewhere; (2) utilize Lander data to improve the orbits of Mars and the Earth, estimate parameterized post Newtonian (PPN) relativity parameters and determine Mars' polar moment of inertia; (3) process Lander radio observations concurrent with observations of background extra galactic radio sources (Differential Very Long Baseline Interferometry - Delta VLBI) to provide precise angular measurements of Mars' position with respect to a nearly inertial dynamical reference frame for use in solar system dynamical and gravitational

studies (performed under OSS RTOP 155-20-70); (4) analyze orbiter radio signals to study the solar corona and solar wind and (5) test relativity by expressing the motions of the planets in terms of the parameterized post-Newtonian (PPN) spacetime metric of Will and Nortdtvedt, and then to determine values of the PPN parameters from the planetary data by the method of weighted least squares.

W80-70583 **155-47-20**
Goddard Space Flight Center, Greenbelt, Md.
MARS DATA ANALYSIS
B. J. Conrath 301-344-6088
(154-20-80)

The Mariner 9 and Viking missions have provided extensive data sets which are available for the study of the Martian atmosphere. Investigations of selected physical processes which may provide new insight into phenomena occurring in the lower terrestrial atmosphere are of particular interest. This investigation studies the following dynamical phenomena in the Martian atmosphere: waves in the stratosphere, dust storms, the influence of the planetary boundary layer on global tides, and local, thermally driven circulations associated with topography. These phenomena are investigated through a combination of data analysis and theoretical modelling.

W80-70584 **155-47-80**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARS DATA ANALYSIS (ATMOSPHERES)
W. T. Huntress 213-354-2140
(155-20-30; 155-41-80; 155-50-01)

This RTOP covers five tasks in the Atmospheres portion of the Mars Data Analysis Program: (1) Mars Atmospheric Water Vapor Studies - D. W. Davies; (2) Martian Atmospheric Thermal Tides - R. W. Zurek; (3) Analysis of Viking Radio Occultation Data - D. N. Sweetnam; (4) Mars Atmospheric Opacity During the Viking Mission - T. E. Thorpe; and (5) Mars Atmosphere Thermal Studies - T. Z. Martin. Proposals for all five have been submitted in the course of Fiscal Year 1979. The fifth task was originally submitted via UCLA.

W80-70585 **155-50-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MDAP GEOLOGY
R. S. Saunders 213-354-3815

The proposal for Mars Data Analysis Geology Investigations consists of six tasks to be carried out in FY-80. Tasks are being performed in a variety of disciplines, including topography, gravity, regolith adsorption, and thermophysical properties of the Martian surface.

W80-70586 **155-50-01**
Goddard Space Flight Center, Greenbelt, Md.
DATA REPRODUCTION IN SUPPORT OF THE MARS DATA ANALYSIS PROGRAM
James I. Vette 301-344-7354
(404-03-01)

The NASA Headquarters Planetary Division has approximately 110 principal investigators. Many of these, in addition to a number of other planetary scientists, will be participating in the Mars Data Analysis Program. Many of these investigators require large quantities of data, especially photographic products to achieve the objectives of their investigations. Such products are only generally available through the National Space Science Data Center (NSSDC). While the size of these NASA-supported requests would normally result in NSSDC's having to charge for services, such funds from university and other nongovernmental investigators would go to the U. S. Treasury. Therefore, these funds would not allow NSSDC to purchase the required photographic supplies of pay contractor labor. On the other hand, the existing budget would not allow NSSDC to supply these investigators with the required data and carry out its normal request activity. For example, NSSDC has received approximately 40,000 feet of 5-inch film containing Viking images. The cost of producing just ten complete sets of contact prints of these images would be about $60,000. A number of investigators will require a complete set of prints and negatives at a cost of about $13,000 each. These additional requests can not be satisfied within the existing NSSDC budget.

Solar Terrestrial SR&T

W80-70587 **170-36-55**
Marshall Space Flight Center, Huntsville, Ala.
PARTICLE AND PARTICLE FIELD INTERACTIONS
Charles R. Chappell 205-453-3036
(385-36-01)

The objectives are to develop space plasma instrumentation for automated spacecraft and sounding rocket payloads. To accomplish these objectives, the following tasks will be performed: (1) complete the development of the differential ion flux probe (DIFP) which is to be used for the measurement of multiply directed, low-energy ion streams. This technique has been applied in laboratory wind tunnel studies and will be flown on two rocket flights into the polar cusp in 1980; (2) continue the design of a swept angle retarding ion mass spectrometer (SARIMS) which is to be used for the measurement of low-energy plasma distributions in the ionosphere and magnetosphere. This instrument will be flown on a mid-latitude sounding rocket in the fall of 1979 and will be upgraded for potential flight on future NASA and DOD missions.

W80-70588 **170-36-55**
Ames Research Center, Moffett Field, Calif.
MAGNETOSPHERIC PHYSICS PARTICLES AND PARTICLE/FIELD INTERACTION
A. Barnes 415-965-5506
(384-47-67; 385-36-01)

Our objective is to improve understanding of the dynamics, origin and termination of the solar wind, turbulence in the solar wind, and to investigate possible effects of solar and interplanetary phenomena on terrestrial weather and climate. Theoretical studies will be conducted and aimed at understanding the large-scale dynamics of the solar wind, its acceleration and heating mechanisms, and waves and turbulence in the solar wind. These studies employ known theoretical techniques of plasma physics and magnetohydrodynamics, and also often require extensions of basic theoretical plasma physics. Theoretical developments will be related to spacecraft plasma and magnetic data, as well as to indirect observations of the solar wind. Theoretical studies of possible reations between variations in solar output (radiation and/or charged particles and magnetic fields) and terrestrial weather and climate will be carried out. These studies include investigation of existing data for evidence of sun-weather effects, and search for mechanisms that can produce such effects.

W80-70589 **170-36-55**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLES AND PARTICLE/FIELD INTERACTIONS
Keith W. Ogilvie 301-344-5904

The object of this research is to increase the knowledge and understanding of non-thermal plasmas occurring in the interplanetary medium and magnetospheres, and also to improve the theoretical description of their properties. This requires continuous improvement in measurement techniques, and interpretation of the results of appropriate space experiments. The interpretation requires corresponding improvements in theory, in numerical techniques, and in methods of data display. Instrument development activity is concentrated on advanced concepts for plasma spectrometers, giving three dimensional velocity distributions magnetometers and radio and plasma wave analyzers.

W80-70590 **170-36-55**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MAGNETOSPHERIC PHYSICS: PARTICLES AND PARTICLE/FIELD INTERACTIONS
E. J. Smith 213-354-2248

The vector helium magnetometer is being developed for use on future missions, especially to the outer solar system where

extremely weak interplanetary or interstellar fields will be measured and where intense planetary fields may also be encountered. JPL scientists and engineers carry out tests and experiments on the fundamental principles of the magnetometer operation and design. Improved components are developed, the design is changed to yield improved performance, and new modes of operation are investigated. When appropriate mission opportunities are announced, the scientific requirements are established and a scientific proposal submitted. The basic objective of the theoretical space plasma physics activity is to provide continuing theoretical support for JPL's and NASA's observational space plasma programs. A theoretical study of the variation of solar wind properties with distance from the sun will be continued with emphasis on the roles of electron heat conduction and shock thermalization in determining the temperature and dynamics of corotating interaction regions. Among the phenomena for which empirical or theoretical explanations will be sought are the apparent decrease in the recurrence period of high-speed streams with distance from the Sun and the source(s) of the low speed solar wind. The interaction of the solar wind with the ionospheres of weakly magnetic and nonmagnetic planets and with comets will also be studied, with emphasis on flow dynamics, induction of magnetic fields, and ion-molecule reactions.

W80-70591 **170-36-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE AND PARTICLE/PHOTON INTERACTIONS (ATMOSPHERIC-MAGNETOSPHERIC COUPLING)
James P. Heppner 301-344-8797

The objective is to develop experimental and theoretical approaches for investigating and understanding the processes which provide strong coupling between the neutral atmosphere, the collision dominated ionospheric plasma, and the collisionless magnetospheric plasma. Within the framework of this overall objective, specific sub-objectives are identified in terms of having: (1) key significance, (2) goals which are attainable with limited resources, and (3) close ties to future projects and programs. Emphasis is placed on the primary forces, electric fields and neutral winds, and the associated transport and energization of particles. Related topics include: electric fields in the earth-ionosphere cavity and their relation to weather processes, electric current systems and associated magnetic field disturbances, the generation of thermospheric winds and gravity waves, atmospheric chemical composition anomalies, the transformation of atmospheric ions to trapped radiation, auroral particle acceleration mechanisms, plasma instabilities producing ionospheric irregularities, etc. New instrumentation is being designed and developed for observations of tracer chemicals and for measurements of low energy particles. Properties of double probes in low density plasmas are being studied with the SCATHA satellite. Models for the diffusion of tracer particles are to be developed for planning future chemical release experiments. The closure of magnetospheric electric fields within the earth-ionosphere cavity is to be studied in support of low and middle atmosphere electric field investigations.

W80-70592 **170-36-57**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE ACCELERATOR FACILITY: MAINTENANCE AND OPERATION OF A CALIBRATION FACILITY FOR MAGNETOSPHERIC AND SOLAR-TERRESTRIAL EXPERIMENTS
James H. Trainor 301-344-6282

The GSFC Sciences Directorate operates a nuclear particle calibration facility consisting of a 2 MeV Van de Graaf and a 250 keV electrostatic accelerator. The facility provides particle energies from 50 eV to 2 MeV, and protons via reactions to approximately 20 MeV. Particle beams available range from electrons to Kr84, with fluxes from approximately 1 particle/sq cm sec to approximately 10 to the 9th power particle/sq cm sec. It is a unique facility in the world in this low energy region. For several years, all work in this facility has been in support of magnetospheric and solar-terrestrial research. Over the period FY-77 through FY-79, machine time has been split fairly evenly between calibration and testing of satellite instrumentation, testing and development of new particle detector systems, and numerous sounding rocket payloads. Requests from foreign experimenters amount to 5% to 15% of the machine time. The facility operates normally on all working days, but the requirements of the experimenters in the past several years have often required operation 6 or 7 days per week and 12-16 hours per day at times. That, coupled with the declining manpower in Code 660, has forced the facility to rely heavily on contractor manpower for maintenance and operation. Demand for the facility remains high with requests received for time allocation into late 1979.

W80-70593 **170-38-51**
Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT OF SOLAR SPACELAB EXPERIMENT AND HARDWARE
R. D. Chapman 301-344-5101

The objective is to develop payloads which contribute to the solution of well defined solar research problems. These activities have the ultimate objective of flying payloads on problem-oriented shuttle spacelab missions. In such missions, a payload of instruments is assembled to provide, by simultaneous observations of a phenomenon such as a solar flare or the outflow of the solar wind at the base of the corona, the thorough detail needed for a cogent model of that phenomenon. An example of such a mission is SMM for solar flare research. This spacecraft will be retrieved by the shuttle and flown again with refurbished instrumentation. This and other research problems will form bases for series of missions using the shuttle. One of these will be a study of coronal structures contributing to the solar wind and the interplanetary plasma. A second will be a study of the sources of high energy particles on the sun, emphasizing instrumentation not accommodated by and/or supplementary to the SMM instruments. Missions emphasizing the phenomenon of coronal heating and mass and energy balance in the chromosphere are also contemplated. In each case a number of different instruments covering a wide range of wavelengths is required. These will be selected on the basis of making comprehensive measurements in their specific wavelength regions in a format coordinated with and complimentary to the other instruments in the payload. For example, all instruments will operate with the same temporal and spatial resolution to the maximum possible extent.

W80-70594 **170-38-51**
National Aeronautics and Space Administration, Washington, D.C.
DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH
J. David Bohlin 202-755-8490

The objective is to develop experiments and instrumentation for space observations or laboratory applications directly related to solar physics research. Additional objectives are the development of critical technology items which are needed for new or significantly improved solar observations. Activities in this program include the development of new or existing techniques and light sources to accurately calibrate ultraviolet (UV) and extreme ultraviolet (XUV) solar experiments intended for operation in space. Existing calibration standards and facilities frequently are insufficient to obtain maximum information return for new and some existing instrumentation. Improved, lightweight, mobile and accurately reproducible transfer standards are much in demand by the experimental community.

W80-70595 **170-38-52**
Goddard Space Flight Center, Greenbelt, Md.
GROUND BASED OBSERVATIONS OF THE SUN
Robert W. Hobbs 301-344-7591

The major objective is the measurement of solar radiation at those wavelengths accessible from the ground with resolution (spatial, spectral, temporal, velocity) suitable for supporting investigations of solar phenomena (flares, active regions, wave motion, velocity fields, and magnetic fields) carried out in the EUV, X-rays, and gamma rays by the Solar Maximum Mission and other flight missions in the NASA Solar Physics Program, and for basic research on the sun. Other objectives are the analysis of comet tail photographs to determine the velocity field of the solar wind; and high resolution radio observations of the sun. Several observatory facilities are supported and maintained for this purpose. The Laboratory provides support

for the Vacuum Tower Telescope at Kitt Peak, which specifically provides HeI 10830A spectrohelograms and magnetogram.

W80-70596 **170-38-52**
National Aeronautics and Space Administration, Washington, D.C.
GROUND-BASED OBSERVATIONS
J. David Bohlin 202-755-8490

Ground-based observations of the sun in wavelengths for which the terrestrial atmosphere is transparent are carried out at a number of suitable observatories and ground stations throughout the United States. The purpose of these ground-based observations is to obtain information on the solar atmosphere from the photosphere and sun spots, to the chromosphere and the corona, and on the fine and gross structure of the solar atmosphere, and activity in it. This information is then used in conjunction with observations from sounding rockets, OSOs, ATM and other spacecraft to determine the physical conditions in the objects studied and to understand the physical mechanisms at work in them. Of particular importance in the coming year will be the initiation of a series of coordinated ground-based observing programs planned in collaboration with the Solar Maximum Mission (SMM).

W80-70597 **170-38-53**
Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENT DEVELOPMENT - LABORATORY AND THEORETICAL SOLAR PLYSICS
R. D. Chapman 301-344-5101

The objective is to develop fundamental techniques which support the Laboratory's on-going programs. These techniques ultimately are both experimental (applicable in the areas of design of flight instruments) and theoretical (analysis of returned data). However, at the initial level of investigation, fundamental physical processes must be investigated and defined before development of solar models based on these processes can be proposed and executed. Likewise, fundamental understanding of spectra observed on the sun is confirmed if not originally suggested by laboratory and theoretical work. Among such work is the identification of spectral lines in high energy spark discharges, the calculation of the transition probabilities of atomic transistions, and the development of techniques for the analysis of spacecraft investigations and for understanding the underlying physical processes. Each of these areas is investigated in the context of ultimate application to instruments or theoretical modeling of the solar atmosphere carried out by members of the laboratory. Included in the theoretical work is the development of techniques for the solution of atomic collision problems involved in processes occurring in the plasmas of the solar atmosphere as well as in other astrophysical plasmas.

W80-70598 **170-38-53**
National Aeronautics and Space Administration, Washington, D.C.
LABORATORY AND THEORETICAL SOLAR PHYSICS
J. David Bohlin 202-755-8490

Laboratory and theoretical studies are performed on problems in solar astronomy, solar physics, and in important and relevant areas of atomic and molecular physics. These investigations contribute basic information which is necessary for the analysis, interpretation, and understanding of data about the sun which is obtained from space and from the ground. Theoretical studies of the sun include the following types of activity: (1) the analysis of ground-based and space data to produce models of the solar atmosphere and solar wind, and to understand the underlying physical conditions and mechanisms which are involved, and (2) theoretical studies of solar flares including models of flare loops, energetic particle acceleration, electron beams and reverse currents, preflare precursors and plasma instabilities. These activities assume added importance during the solar maximum period when energetic flares will occur and be observed more often.

W80-70599 **170-78-60**
Goddard Space Flight Center, Greenbelt, Md.
ORIGIN OF PLASMAS IN THE EARTH NEIGHBORHOOD (OPEN)
William Hibbard 301-344-7697

The objective is to develop the scientific and technical basis for a Solar Terrestrial Multisatellite mission to be proposed for flight in FY85-86. The objective of this mission is to provide simultaneous, coordinated measurements of the role of plasmas in the transport, storage and dissipation of energy in the solar wind and the terrestrial magnetosphere. The approach will be to conduct preliminary system design studies (feasibility) in the areas of sensors and/or instrument requirements design, mission analysis, system definition and design, and ground data processing systems to meet requirements established by the Solar Terrestrial Program Office and its appointed science working group. These studies will form the basis for the publication of a Preliminary Execution Phase Project Plan (PEPPP) in FY-79. Another product of this effort will be the preparation of a Mission Need Statement to meet the requirements of OMB Circular A-109 which, together with the Preliminary Systems Design Group (PSDG) study activity, will form the basis for the RFP requesting alternate system design concepts from industry.

W80-70600 **170-78-61**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR CYCLE & DYNAMICS MISSION (SCADM) SCIENCE STUDY FOR A SOLAR SATELLITE MISSION
David Suddeth 301-344-7697

The objective is to develop the scientific and technical basis for an Earth orbiting, Solar Study satellite mission to be proposed for flight in the FY87-88 time period. This mission is to make continuous observations of the sun, with high resolution of time and images, and to make coordinated observations with other spacecraft such as the Solar Polar Mission, which would greatly enhance the value of the solar data thus obtained. It may also prove cost effective to utilize refurbished portions of the Solar Maximum Mission spacecraft, currently scheduled for retrieval in late 1981. The approach will be to conduct preliminary system design studies (feasibility) in the areas of instrument requirements and design, mission analysis, systems definition and design, and data processing systems, to meet requirements established by the Solar Terrestrial Program Office and its appointed science working group. The studies include both inhouse Preliminary Systems Design Group (PSDG) and out-of-house (contract/grant) activities in the areas critical to proof of feasibility or of cost effectiveness of alternate approaches, including such areas as science, mission analyses, engineering studies, information handling system and management guidance.

Controlled Ecology Life Support Systems

W80-70601 **174-03-02**
Ames Research Center, Moffett Field, Calif.
LIFE SUPPORT REQUIREMENTS FOR CELSS
E. L. Merek 415-965-5768

The objective is to develop a regenerative food production system for a CELSS ground based demonstrator. The amounts and types of food products required and groups of plants capable of supplying these requirements will be identified. Plants with respect to their nutritional requirements, stability and reliability, atmospheric revitalization and water reclamation capabilities, toxins and wastes produced will be characterized. Plants through growth and product analyses in simulated CELSS environment will be evaluated. Plant production techniques will be evaluated. Test candidate plants and methods in simulated CELSS environment in conjunction with waste management and systems management developments. Life support unit will be integrated into CELSS ground based demonstrator.

W80-70602 **174-05-02**
Ames Research Center, Moffett Field, Calif.
WASTE MANAGEMENT FOR CELSS
T. Wydeven 415-965-5738

The objective of this program is to develop the technology required to process wastes and generate plant nutrients in a Controlled Ecological Life Support System (CELSS) in space. A model of the waste products to be processed by the waste management system in a CELSS for use in space will be developed. Additionally, definition studies for each of the waste management subsystem technologies that have been identified to date as candidates for CELSS will be undertaken. The candidate subsystems are wet oxidation, incineration and biological oxidation. Emphasis in the definition studies will be placed on determining the adaptability of a given waste management subsystem to a CELSS wherein the output from the waste management subsystem must be used as inputs for other elements of the life support system.

W80-70603 **174-07-02**
Ames Research Center, Moffett Field, Calif.
SYSTEMS MANAGEMENT, CONTROL, AND ECOLOGICAL CONSIDERATIONS FOR CELSS
R. D. MacElroy 415-965-5573

The objectives are to develop the methods and techniques required to operate and manage a Controlled Ecological Life Support System (CELSS); to develop and apply computer programs to the control of fabricated, isolated systems containing plants, animals and/or microflora; to utilize this system to investigate ecological interactions among organisms; and to establish a reliable, accessible data base for the purpose of enhancing the control of the system. Development of system control and safety will be approached through the formulation of computer programs capable of accessing and analyzing data sensed from a small, isolated, nonregenerative system. After analysis, specific physical controls will be exerted in order to maintain system homeostasis, or some desired series of system states. The same system, because of its ability to gather and analyze data, will be used by other investigators of the CELSS program to investigate specific ecological interactions. This, and other separately gathered data, both from within and from outside of the CELSS program, will be used to establish a pertinent, accessible, and reliable data base for future CELSS investigations.

Planetary Exploration SR&T--Advanced Technical Development

W80-70604 **186-68-96**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMET SCIENCE STUDIES: DUST AND INFRARED
M. Neugebauer 213-354-4110
(156-06-04)

The objective is to assure the optimal design and technological readiness of the scientific instruments for use on NASA's first comet mission. Particular emphasis is placed on the monitoring and collection of cometary dust for on-board analysis and on infrared studies of the cometary coma and nucleus. A dust gun and a sensitive microbalance will be used to determine the optimum dust collection and monitoring strategies. Once dust experiments have been selected for the comet mission, their requirements will be compiled and used to design a flight-type dust collection and distribution system. A thermal model of Comet Tempel 2 will be completed and published. The feasibility of using pressure modulated radiometers for determining the composition of a cometary atmosphere and the surface temperature of the nucleus will be studied theoretically and critical aspects of such an experiment will be tested in the laboratory.

Astrophysics SR&T

W80-70605 **188-41-51**
National Aeronautics and Space Administration, Washington, D.C.
ULTRAVIOLET AND OPTICAL ASTRONOMY
E. J. Weiler 202-755-3687

The objective is the advancement of stellar, galactic, and extragalactic astronomy through observations and interpretations of data secured in the ultraviolet and visible portions of the electromagnetic spectrum. The emphasis is on research in direct support of current and past flight programs or in anticipation or preparation for future ones. The four elements supported are laboratory astrophysical studies, theoretical astrophysics, instrumentation development, and direct observational programs. A balanced program involving all four elements is required in order to ensure the full utilization and the healthy development of the space science program with the goal of the advancement of our understanding of the universe. The approach includes the following: the development of theoretical models, the performance of theoretical studies, and the determination of basic atomic and molecular parameters. Interpretation of data, especially that obtained in the relatively unexplored UV spectral region, requires the additional information provided by these efforts. A broad and sound theoretical framework allows new observations to be interpreted and new directions to be instituted. In addition to atomic and molecular physics, specific areas of study include stellar atmospheres, stellar systems, compact objects, interstellar grains and cosmology.

W80-70606 **188-41-51**
Marshall Space Flight Center, Huntsville, Ala.
UV AND OPTICAL ASTRONOMY
C. R. ODell 205-453-3033

An observational and interpretive program of astronomical spectroscopy will be pursued using the Echelle grating nebular spectrograph. This will include a program of observations and data interpretation concerning internal velocities in HII regions. Identified and candidate optical counterparts to X-ray sources will be observed with the objective of providing a more complete understanding of the nature and distribution of the X-ray sources. Methods of high time resolution photometry, spectrophotometry, and polarimetry will be applied utilizing, among other observational equipment, the video detector systems and photon counting equipment. The observations will also include selected cataclysmic variables not now known to be X-ray sources.

W80-70607 **188-41-51**
Goddard Space Flight Center, Greenbelt, Md.
UV AND OPTICAL ASTRONOMY
A. Boggess 301-344-5103

The objective is to pursue a long range program in astronomical research with emphasis on optical observations, theoretical astrophysics, and other specific topics of special interest to NASA. The effort including operation of ground telescopes, development of new instrumentation for ground and rocket use, data interpretation, and theoretical studies. Spectroscopic and photometric data are obtained from ground telescopes in order to analyze the properties of stellar atmospheres, nebulae, and the interstellar medium. Nonequilibrium model atmospheres are being investigated to interpret spectral observations from space and ground observatories. Theoretical investigations are carried out in formation and evolution of galaxies and on the evolution of stellar interiors, variable stars, novae, and planetary nebulae.

W80-70608 **188-41-51**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
UV AND OPTICAL ASTRONOMY
W. T. Huntress 213-354-2140

Laboratory work will be conducted to measure the products and rate constants for ion-molecule reactions leading to the synthesis of molecular and ionic species in interstellar clouds. This SR&T work is supportive of observational work on interstellar molecules, and provides data to help interpret the abundance of observed interstellar molecules, and to predict new species. The

data are used in our model and in other models of interstellar clouds, and are used to describe molecular evolution in astrophysical environments. Laboratory measurements will be performed on electron-atom/molecule collision cross sections for atoms and molecules found in the interstellar medium. The data generated by these measurements will be used in modeling as well as in testing various theoretical calculations for electron-molecule collision cross sections. These calculations can then be used to predict electron attachment cross sections, negative ion binding energies, dissociative attachment cross sections, etc., for very low energy electron-molecule collision processes taking place in the interstellar clouds. High resolution (0.02nm) UV photoionization studies will be carried out on interstellar gases. A new technique for measuring threshold photoelectron spectra will be used to (1) study electronic structure of atomic, molecular and radical ions produced by UV radiation from hot stars, and (2) measure absolute threshold photoionization cross section for states of atomic, molecular and radical species important in ionization equilibrium models.

W80-70609 **188-41-52**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PULSAR ROTATION CONSTANCY
G. S. Downs 213-354-2765
(389-41-01)

The periods of pulsating radio sources (pulsars) are known to deviate from a simple spin-down model in an unpredictable but well documented manner. These deviations are due to discrete changes in the pulse period and its first derivative. The objective here is to monitor the pulse period, documenting the occurrence, size and type of each event. Where period activity is low, pulsar positions are to be determined. Proper motions are also to be sought. Observations are to be continued until the source of these period instabilities is understood theoretically. There is a strong suggestion that processes internal to the neutron star are at the root of the period irregularities. The approach requires the measurement of pulse arrival times at regularly spaced epochs (one week to one month). The recorded signals are processed by computer to yield final estimates of the arrival times. These results will be viewed regularly in a least squares model fit to determine if discrete changes in the period model have occurred. Data will be collected at DSS 12, 13, 14 and 62. Data will be published at the end of FY-82. The observing program will be reviewed during FY-82.

W80-70610 **188-41-53**
Goddard Space Flight Center, Greenbelt, Md.
INTERACTIVE ASTRONOMICAL DATA ANALYSIS FACILITY
Daniel A. Klinglesmith, III 301-344-6541

The objective is to support the Interactive Astronomical Data Analysis Facility that currently exists in Code 685, and to continue to support the development of interactive digital computer software techniques for correcting and analyzing astronomical images. The existing facility provides the capability for the display, enhancement and analysis of any digitized images. The facility is currently used by both GSFC astronomers and general astronomical community. This would provide for the maintenance of the existing hardware and system software as well as the continued development of software techniques for the analysis and display of both astronomical imagery and spectra. The software techniques that are to be developed will include geometrical correction of distorted imagery, noise analysis and removal using FFT techniques, contour mapping and display, edge detection, intensity transfer function corrections and profile fitting.

W80-70611 **188-41-54**
National Aeronautics and Space Administration, Washington, D.C.
RELATIVITY
N. G. Roman 202-755-3687

The primary objective is to use space techniques to test various predictions of theories of gravitation, particularly Einstein's general theory of relativity. Because gravitational interaction is very weak, its measurement with high accuracy is very difficult. The use of space techniques allows experiments involving the large masses of solar system members and the large distances of interplanetary space to be used in these tests, making possible discrimination among the predictions of various theories. The current program is largely theoretical. The development of a cryogenic gyroscope to measure the precession of a gyroscope in earth orbit as a result of the frame dragging of the earth's gravitational field as it rotates, which has supported in this program for many years is now supported under advanced development in preparation for a new start in the near future. A start is being made on the detection of gravity waves either through the perturbation of a space probe relative to the earth or by accurate measurement of the separation of two bodies in earth orbit at least several kilometers apart. Theoretical analyses of both approaches are being supported. Another study analyzes the tracking data from planetary probes for relativistic effects and optimizes the trajectories for future probes. Other studies provide more general background on possible tests of gravitational theories.

W80-70612 **188-41-54**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RELATIVITY
F. B. Estabrook 213-354-3247

Research is being performed on the interaction of gravitational radiation with Doppler spacecraft tracking measurements, and on various possible detection methods for gravitational radiation. Feasibility studies are being made on precision tracking experiments utilizing the unique experimental capabilities of the Deep Space Net. It has been shown that an observational window exists, for radiation of periods between 20 sec and 3000 sec; in this range, Doppler measurements are possible to the sensitivity limits set by H-maser timekeeping. Catastrophic collapse of distant galactic or quasar nuclei and collision between supermassive black holes in them may generate pulses of radiation in this range, and these pulses would produce a unique response in the Doppler tracking record. Possible local sources and sources of continuous wave trains are also being considered. Forthcoming interplanetary missions are being studied, and data reduction algorithms derived. The possibility of missing matter in the universe has been studied by computer integration of evolutionary models of the intergalactic medium. This research supports interpretation of data on intergalactic matter, its composition, excitation and ionization history, being taken under a 1979-80 observing program entitled Ultraviolet Observations of Quasistellar Objects and the Intergalactic and Intercluster Medium by the International Ultraviolet Explorer Satellite.

W80-70613 **188-41-55**
Ames Research Center, Moffett Field, Calif.
THEORETICAL ASTROPHYSICS
D. C. Black 415-965-5495

The objective is to conduct theoretical studies on important fundamental problems in astrophysics and astronomy and to provide theoretical support for the Center program in observational infrared astronomy. Although a wide range of astrophysical phenomena are under investigation, research efforts are primarily directed towards infrared astronomy and computational astrophysics. Theoretical work in infrared astronomy includes studies of fragmentation of interstellar clouds and subsequent collapse to the main sequence, investigation of the structure of molecular clouds, modeling of dusty HII regions, as well as data interpretation of airborne infrared observations. The computational astrophysics program underway encompasses a broad spectrum of hydrodynamic and stellar dynamic problems in astrophysics including pre- and post-main sequence evolution, galaxy formation and evolution, accretion, plasma astrophysics, the dynamics of gas acceleration near QSO's, and luminosity fluctuations of BL Lacertae objects, QSO's and active radio galaxies. A variety of other astrophysical problems are also being investigated.

W80-70614 **188-41-55**
National Aeronautics and Space Administration, Washington, D.C.
INFRARED ASTRONOMY
N. W. Boggess 202-755-3688

The objective is to advance stellar and galactic astronomy

in the spectral region between 1 and 1000 microns through observational and theoretical programs. Observations in the infrared portion of the electromagnetic spectrum are particularly important for an understanding of the early and late stages in stellar evolution, interstellary matter, galaxies and quasistellar objects and the energy mechanisms associated with them, and interpreting the residual radiation from the origin of the universe. A balanced program including observation, technique and instrumentation development, and theory is required to ensure the advances needed for full utilization of future platforms in space. The approach includes the following elements: (1) detector development, (2) improvement of instrumentation, (3) ground based and balloon observations, and (4) theoretical studies.

W80-70615 **188-41-55**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADIO ASTRONOMY
S. Gulkis 213-354-5708

In the observations task, we are continuing a program of ground based millimeter wave spectroscopy using the new 10 m antennas at the Owens Valley Radio Observatory. The 1.7 mm receiver, which was assembled and operated in 1978, will be employed in observations of SiO, H2S and, weather permitting, HCN. We also hope to expand the operating range towards 150 GHz (for H2CO when weather prevents higher frequency operation) and into the 200-300 GHz range. We plan to continue observations of interstellar water with the Kuiper Airborne Observatory, and of galaxies, planetary nebulae, and extended HII regions with the Deep Space Network. The laboratory task will expand a program of millimeter and submillimeter measurements of molecules of astrophysical interest, and when the catalogue work indicates a deficiency in the existing data. The catalogue of transitions of astrophysical molecules which now comprises 32 molecules and 68 isotopic variations, will be consolidated and appropriate parts submitted for publication. In the Tidbinbilla Interferometer task, we propose to carry out position measurements on a variety of weak radio sources in the Southern Hemisphere. The interferometer utilizes the 26 m and 64 m antennas of the Deep Space Network near Canberra, Australia. It is the most sensitive interferometer in the Southern Hemisphere. Using this instrument we plan to develop a catalogue of precise positions with an ultimate view to obtaining optical indentifications.

W80-70616 **188-41-55**
Goddard Space Flight Center, Greenbelt, Md.
INFRARED AND RADIO ASTRONOMY
M. J. Mumma 301-344-6994
(196-41-54; 198-10-01; 154-20-80)

The scientific objective of this program is to provide better understanding of the energetics, dynamics, compositions, excitation conditions, and evolution of solar system objects, stars, proto-stars, dust clouds, HII regions, galactic emissions and extrgalactic objects. This is achieved by observations of these objects at wavelengths from 1 micron to 10 cm and at spectral resolutions LAMBDA/DELTA LAMBDA from approximately 1 to 10 to the 6th power. Since atmospheric opacity and emissivity prohibit or severely limit ground-based observations at certain wavelengths (4-8 microns and 13-700 microns, high altitude observational platforms such as the C-141, balloons, or satellites must be used. High sensitivity composite bolometers are being developed in the far infrared to take maximal advantage of low background conditions achievable at these altitudes. A balloon-borne 1.2m telescope is being developed to conduct a high sensitivity, low spatial resolution, multicolor photometric survey of Galactic sources of submillimeter radiation, and at least a partial survey of extragalactic sources at these wavelengths. Infrared and millimeter/submillimeter coherent (heterodyne) spectrometers are used to measure completely resolved intensity profiles for neutral and ionized molecular and atomic lines. Millimeter lines are primarily rotational transitions, while infrared lines are mainly vibrational transitions. Correlative studies are made when possible to enable maximum insight into the physics of the medium. Infrared coherent spectrometers based on tuneable semiconductor lasers are being developed for astrophysical use.

W80-70617 **188-46-56**
Marshall Space Flight Center, Huntsville, Ala.
PARTICLE ASTROPHYSICS
Thomas A. Parnell 205-453-5133

The program consists of observations and interpretation of data to ($4 < Z$) and cosmic gamma rays between 0.1 and 10 MeV. Emphasis is also placed on the improvement of instrumentation and data analysis techniques for further measurements of these particles and for application to Spacelab era experiments. Observations of the nuclei and gamma rays are performed on balloon flights; and measurements of detector response are made in the laboratory and at particle accelerators. Calculations concerning sources of particles, local background, and detector response are carried out and verified by measurement.

W80-70618 **188-46-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE ASTROPHYSICS AND SHUTTLE EXPERIMENT DEFINITION
F. B. McDonald 301-344-8801

The objective is to study the properties of the cosmic radiation in order to understand its origin and propagation, and to study the properties of the sites in which element synthesis takes place. The particles observed are the nuclear and electronic species of the cosmic ray particles; their energy spectra, their charge and isotopic composition, and their distribution in space. Some of these objectives can be met through the imaginative use of short duration observations on balloons. Many will require heavier, large area payloads for which the space shuttle will be an ideal observation platform especially in the sortie mode. The details of the chemical composition of the particles as a function of energy is intimately related to the propagation process and must be completely understood in order to determine the cosmic ray path length distribution and hence, the spatial distribution of cosmic ray sources. In addition, this will determine the injection spectrum of cosmic ray nuclei. The high energy composition measurements are essential in order to determine the source abundances of the rarer cosmic ray nuclei. Isotopic composition will enable us to prove the nucleosynthesis going on in the cosmic ray sources. The observation of enhanced 22Ne, first reported by our group and now being confirmed by others is a prime example of the nonsolar nature of cosmic ray material.

W80-70619 **188-46-56**
National Aeronautics and Space Administration, Washington, D.C.
PARTICLE ASTROPHYSICS
Albert G. Opp 202-755-8493

The objective is to study the isotopic and charge composition and energy of galactic and solar cosmic rays. The primary galactic radiation represents the direct penetration of material from the galaxy into the solar system. The study of the nuclear composition and energy of this material provides direct evidence of the stellar processes responsible for the cosmic radiation and information on the interstellar material transited by the cosmic radiation. The observation of solar cosmic rays provides information on the abundances of different elements in the sun, and information on the solar processes that accelerate energetic particles to observed energies. The design, construction and test of cosmic ray detectors is the prime activity supported by this RTOP.

W80-70620 **188-46-57**
Goddard Space Flight Center, Greenbelt, Md.
GAMMA RAY ASTRONOMY
C. E. Fichtel 301-344-6281

The technical objective is to develop the most appropriate detector systems for the observation of the astrophysical sources of very energetic photons. The first approach to the general problem of gamma ray astronomy was the development of a large high energy telescope using digitized spark chambers. Many major improvements to this basic telescope system are still being pursued and other approaches to detector systems are now being developed for the high energy gamma rays, intermediate gamma ray studies, and low energy gamma ray observations. In the low-energy gamma ray region, 0.03 to 10 MeV, much of the radiation may consist of monoenergetic line components; therefore

high resolution spectrometers are being developed which will be capable of sufficient precision to resolve lines as narrow as may be found in nature. In the medium energy interval (approximately 6 to approximately 0 MeV), a first generation gamma ray detector was built and flown on a balloon, and a second generation experiment is now nearly ready for a balloon flight. In the high energy region improvements in the track imaging chamber systems are continuing and special attention in the track imaging chamber research is now being directed at building a chamber of significantly larger size. At the same time, several approaches are being explored to improve angular resolution, including techniques to concentrate on higher energy photons. Time of flight systems have been developed to improve the rejection rate of events which are not gamma rays and other rejection systems are being studied.

W80-70621 **188-46-57**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
GAMMA-RAY ASTRONOMY
A. S. Jacobson 213-354-6263

This describes the JPL program in X- and gamma ray astronomy, part of which is a cooperative effort with UCSD. The primary objective of the program is to observe nuclear gamma ray line spectra from extraterrestrial sources in the .02 to 10 MeV energy range. Such observations could provide important information on nucleosynthesis, galactic history and the physical nature of various celestial objects including cosmic X-ray and gamma ray sources, both constant and transient. Under this program, an existing high resolution gamma ray spectrometer balloon system will be used in a series of astronomical observations. Additionally, development of a new, significantly larger balloon system will continue. The specific objectives for this program for FY-80 are to begin the design of the next generation high spectral resolution gamma ray telescope, initiate the procurement of several large volume high purity germanium crystals, and conduct observational balloon flights from Palestine, Texas with the existing detector system.

W80-70622 **188-46-57**
National Aeronautics and Space Administration, Washington, D.C.
GAMMA RAY ASTRONOMY
Albert G. Opp 202-755-8493
(188-46-59)

The objective is to measure the characteristics of energetic photon emission from celestial sources, and to understand the physical processes responsible for the emissions. This RTOP includes photonic radiation from approximately 10 keV in energy upward to as high as can be measured, that is, from hard X-rays to ultra high energy gamma rays. Several sources have been identified, which have spectra extending into the hundreds of MeV or higher. The spectra of discrete sources and the spectra and distribution of the diffuse background will provide information on the physical processes active in stars, pulsars, galaxies and interstellar space. Gamma ray photons result from a number of physical processes. These processes can furnish information on the synthesis and distribution of elements in the universe, on the magnetoplasma environment of a star, on the interaction of cosmic rays with interstellar material, as well as other astrophysically important parameters. Gamma rays, which are undeflected by magnetic fields, travel directly from their sources, and anisotropies in the direction of arrival of the photons gives information on the location of the gamma ray sources.

W80-70623 **188-46-59**
Marshall Space Flight Center, Huntsville, Ala.
X-RAY ASTRONOMY - TIME VARIABILITY AND POLARIMETRY
Martin C. Weisskopf 205-453-5133

Research will be conducted in the field of X-ray astronomy in areas related to the astrophysics programs of NASA. We will analyze and interpret existing satellite and ground-based observations of the time variability of the aperiodic X-ray sources and their optical counterparts with emphasis on the black hole candidates. Auto-and cross-correlation techniques, shot model, and pulse-shape-innovation techniques will be utilized to determine the underlying pulse shape and stability as a function of time. We will determine the degree of the contamination of the OSO-8 X-ray polarization data by solar X-rays polarized due to electron scattering. This task will be accomplished by correlating solar intensity measurements obtained with an X-ray heliometer also aboard the satellite. We will design, build, test, and fly in a sounding rocket an advanced X-ray polarimeter. The polarimeter will utilize the polarization dependence of the photoelectric effect and, in particular, the angular dependence of certain fluorescence photons on the linear polarization of the incident X-rays.

W80-70624 **188-46-59**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY ASTRONOMY
E. A. Boldt 301-344-5853

Celestial X-ray sources have introduced us to rich new aspects of astronomy ranging from the millisecond bursts of hard X-rays coming from the innermost orbits of matter falling into a black hole to the beamed emission associated with accretion of matter onto a rapidly rotating highly magnetized neutron star. The combination of large sensitive area, low detector background, high temporal resolution and non-dispersive spectroscopy over a broad bandwidth has been our approach in discovering and exploring these phenomena. The power of this approach is being well demonstrated. Extending it with improved spectral resolution and broad band imaging is a major area of development now indicated. This involves the creation and evaluation of new systems incorporating low noise ionization counters of optimum resolution, large area X-ray concentrators and imaging devices. Dispersive spectroscopy is introduced in a new task for the development of a conical crystal spectrometer.

W80-70625 **188-46-59**
National Aeronautics and Space Administration, Washington, D.C.
X-RAY ASTRONOMY
Albert G. Opp 202-755-8493
(188-46-56; 188-46-57)

The objective is to investigate and understand the nature of sources of X-ray emission. The number of such sources detected has been increasing by virtue of the active observational program being conducted with balloons, rockets, and satellites. As experimental techniques have been refined, a number of point sources have been identified with unusual optical objects both galactic and extragalactic in origin. In addition, X-ray variability of different characteristic forms has been found; some sources are analogous to the radio and optical pulsars. The general cosmic X-ray background, as well as the point sources need further study in order to elucidate the emission mechanism and the cosmological significance of these objects. Specific objectives are the detection of additional sources, spatial mapping of the background accurate positional determination, and correlation with optically identifiable objects. These objectives are met by supporting laboratory studies, flight programs, and theoretical work. Research and development of advanced detectors, shielding systems, and focusing optical systems are being conducted. Data processing methods are being refined.

W80-70626 **188-48-51**
Marshall Space Flight Center, Huntsville, Ala.
INTERDISCIPLINARY SPACE SCIENCE RESEARCH
C. R. ODell 205-453-3033

The objectives of this study are: (1) to conduct space science research in various scientific and technical disciplines related to the astrophysics programs of NASA, and (2) to provide a quick reaction capability of supporting research tasks unforeseen or which encounter unexpected difficulties, and which enhance the inhouse scientific capabilities of the MSFC. Under the direction of the Associate Director for Science, research is initiated in astrophysics related scientific and technical areas that support the scientific missions of the Center. Research tasks selected for funding under this RTOP will contribute to the advancement of inhouse capabilities and the state-of-the-art.

W80-70627 **188-78-01**
Goddard Space Flight Center, Greenbelt, Md.
COSMIC RAY OBSERVATORY
Curtis Stout 301-344-8566

The objective is to develop the scientific and technical basis for extended cosmic ray observations to be proposed for flight begining in FY-89. The objective of these studies is to provide answers to questions regarding the origin, acceleration and propagation of cosmic rays and to provide new insights into the nucleosynthesis of the elements and the physics of particles at ultra high energy. The approach will be to conduct studies in the areas of the science, the mission analysis and the system design and definition in support of the headquarters program office and its appointed science working group.

W80-70628 **188-78-51**
Marshall Space Flight Center, Huntsville, Ala.
LOW GRAVITY SUPERFLUID HELIUM ADVANCED TECHNOLOGY DEVELOPMENT
R. Decher 205-453-5130

Several experiments are currently being developed which will require a low temperature environment for their proper operation in space. Superfluid helium will undoubtedly be used for many of these applications. Immediate application to experiments are to be found in cosmic ray, relativity and infrared astronomy. The purpose of this research is to investigate theoretically and experimentally, where possible, the properties of superfluid helium to be expected when liquid helium dewars are flown into space. The properties of superfluid helium in this near zero gravity environment will be assessed and methods will be investigated whereby problem areas may be resolved and/or controlled. The goal of this effort is to support the development of liquid helium dewar technology for space.

W80-70629 **188-78-51**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED TECHNOLOGICAL DEVELOPMENT, GENERAL: SIGNAL AND DATA PROCESSING ELECTRONICS; SOLID STATE DETECTORS
James H. Trainor 301-344-6282

The objectives of this research project are to develop and test new onboard signal handling, data processing, storage, computing and auxiliary electronics circuitry for use in energetic particle and astrophysics experiments on spacecraft, rockets, balloons, etc., as well as special test and analysis equipment applicable also for both ground and shuttle usage. The growing complexity of experiments and the often corresponding increase in the volume of data obtained have made signal handling, data processing and data transmission capability limiting factors. To reduce the transmission of unnecessary data, it is necessary to increase the experiment's onboard signal handling and data processing capability. This program is approached through (1) the investigation and development of new techniques for signal shaping and handling, data processing and auxiliary circuitry, and (2) the modification of existing techniques by the application of advanced technology and materials including MOS/LSI technology, thick film techniques, multiple chip techniques and microprocessors. The technical objective of the research project is to conduct a program of research and development, and device test and evaluation in the field of silicon and germanium nuclear radiation detectors with emphasis on (1) the improvement of detector technology; (2) the understanding of the radiation damage effects on device operation and lifetime; (3) the understanding of the effects on these detectors of chemicals commonly used near or on spacecraft; (4) to establish the technology for the fabrication of specialized devices not available from industry; and (5) to continue the pragmatic life testing.

W80-70630 **188-78-60**
Goddard Space Flight Center, Greenbelt, Md.
GAMMA RAY OBSERVATORY (GRO)
Jeremiah J. Madden 301-344-7593

The objective of the Gamma Ray Observatory (GRO) is the study of the most energetic photons originating in our galaxy and beyond. These photons provide the most direct means of studying the largest transfers of energy occurring in astrophysical processes. Specific studies will include the dynamic high energy processes occurring in compact objects; examination of supernovae to determine if there has been nucleosynthesis; a search for gamma ray point sources and their properties; gamma ray bursts; and the detection and examination of other galaxies. A definition project will be established within GSFC to carry out the system definition phase activities. These activities will include inhouse and contracted studies to prepare the GRO Project for the execution phase. At the conclusion of the definition phase, a project plan will be submitted to headquarters.

W80-70631 **188-78-60**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
GRAVITATIONAL EXPERIMENTS IN SPACE
J. D. Anderson 213-792-3956

The objectives are to define a set of space missions that will yield data on the nature of gravitation; describe in quantitative terms the contribution of each mission to experiment gravitation; and specify any new or peculiar technological requirements that gravitational experiments will impose on future space missions. A study of the proposed solar probe and Venus orbiter missions is a primary objective of this investigation. Recommendations on the relative merits of the two missions, from the viewpoint of experimental gravitation, will be delineated as clearly as possible. Existing software will be used to perform a covariance analysis for the solar probe and for Venus orbiter. In addition to the important Newtonian parameters for each mission, it will be necessary to include several post-Newtonian parameters (PPN) in the analysis, as well as the solar gravitational quadrupole moment J sub 2, and possible time variations and nonisotropic terms in the gravitational constant G. The analysis will be conducted within a framework of realistic technological constraints on both missions.

W80-70632 **188-78-61**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED MISSION STUDY - GRAVITY PROBE B
Richard A. Pottor 205-453-3430

The objective of this activity is to develop, through a coordinated program, the technology and research required to support the flight of the gyro-relativity experiment. This experiment will be a fundamental and unique test of the general theory of relativity. The feasibility of this experiment centers around the development of a cryogenic gyroscope several orders of magnitude more precise than any existing, and the ability to maintain these gyroscopes and record their precessions, while in Earth orbit, over a period of approximately one year. The work, requiring advancement in several disciplines, is being accomplished by complementary efforts at MSFC, Stanford University and the University of Alabama in Huntsville. This work is a well coordinated, theoretical, experimental and engineering program oriented toward a satellite flight that will establish the validity of the general theory of relativity.

W80-70633 **188-78-62**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED MISSION STUDY - ADVANCED X-RAY ASTROPHYSICS FACILITY
James O. Ballance 205-453-3431

The Advanced X-Ray Astrophysics Facility (AXAF) will provide a means to make X-ray observations to study stellar structure and evolution, large scale galactic phenomena, the nature of active galaxies, and rich clusters of galaxies of cosmology. The telescope will extend these observations to the coronas of main sequence and giant, late type stars, and to peculiar stars. It can resolve clusters of galaxies at extreme distances. This initial study will develop the necessary design for a long life (approximately 10 years), high angular resolution (approximately 0.5 sec), greater sensitivity grazing incidence telescope facility. This large free flying spacecraft will be designed for refurbishment and replacement of instruments as well as the supporting subsystems. Specific major trade activities will include the optical design parameters, surface materials and fabrication techniques, image plane alignment, etc. Support modules to provide basic requirements, such as those developed for the space telescope

on the Multi-Mission Spacecraft, will be considered for the observatory.

Planetary Biology

W80-70634 **192-55-61**
Ames Research Center, Moffett Field, Calif.
CHEMICAL EVOLUTION
H. P. Klein 415-965-5094
(192-55-66; 192-55-67)

The objective is to understand the origins and chemical evolutionary pathways of organic matter in the cosmos which led, in the case of the Earth, to the emergence of life but which, in extraterrestrial environments, may have taken divergent paths. Chemical evolution research encompasses the study of the evolutionary path of carbon and its compounds from the primal fireball, through interstellar clouds, to formation of solar systems, to the beginnings of life on Earth. In experiments conducted under conditions designed to simulate the putative environments of cooling solar nebulae, cometary heads and tails, and primitive and contemporary planetary atmospheres and surfaces, the extent and nature of abiotic synthesis of organic matter is determined. Natural evidence bearing on the validity and generality of the chemical evolution hypothesis is sought through organic and inorganic analyses of materials having extraterrestrial (e.g., meteorites, lunar samples, interstellar dust grains, Martian soil) and ancient and recent terrestrial origin. The intimate association of minerals with organic matter everywhere in the cosmos and their necessary cogenesis and co-evolution make it essential to understand the influences of one on the other. Through combined study of the organic geochemistry and the mineralogy and petrology of natural samples will come the firm understanding of the geochemical and geological constraints that will permit reconstruction of ancient and prebiotic environments.

W80-70635 **192-55-65**
Ames Research Center, Moffett Field, Calif.
BIOINSTRUMENTATION
H. P. Klein 415-965-5094

The objective is to develop instrumentation and techniques for the characterization of Mars surface material for species related to the evolution of chemical and biological activity on that planet. The unified experiment for chemical and/or biological characterization of Mars surface material has been developed. Using hardware concepts and results derived from Viking, advanced concepts are being studied for detection of important chamical species on Mars. In-house research, including support of interpretation *of the results of the Viking Biology experiment using the TSM* hardware, has continued.

W80-70636 **192-55-66**
Ames Research Center, Moffett Field, Calif.
PLANETARY ENVIRONMENTS - ORGANIC CHEMISTRY
H. P. Klein 415-965-5095
(192-55-61; 192-55-67)

The objective is to provide specific compositional information on the terrestrial and outer planet atmospheres and surface matter, comets and asteroids to better construct pertinent models of planetary chemical evolution and status which are required for understanding the conditions necessary for the origin of life in our solar system and for establishing the probability of life in the universe. Methods and instruments are being developed for in situ and remote analyses of planetary and cometary atmospheres and surface materials for instrumented probes, penetrators, landers, flybys and orbiters as well as for samples returned from meteoritic and planetary sources. Concepts are being formulated and tested in the laboratory to: (1) detect and measure candidate constituents for each of the prospective planetary atmospheres, (2) detect and measure extant extraterrestrial organisms and their activity, or fossil remnants, in soils, and (3) detect and measure chemical potential, organic, and biogenic substances in soils. Advanced plans are being formulated in which critical concepts will be tested for developing a containment facility for the analysis of returned planetary samples.

W80-70637 **192-55-67**
Ames Research Center, Moffett Field, Calif.
ORIGIN AND EVOLUTION OF LIFE
H. P. Klein 415-965-5094
(192-55-61; 192-55-66)

The objective is to explore the mechanisms, processes, and environments associated with the origin(s) and evolution of life on Earth and to ascertain to what extent they represent constraints within which life can develop elsewhere in the Universe. To utilize such information to design models lending themselves to experimental verification. The origin of life represents a point on a continuum that characterizes the physical, chemical, and biological evolution of matter. While experimental verification of hypotheses concerned with cosmological and chemical evolution can be carried out on the extraterrestrial stage, studies on the origin and evolution of life are limited to the only experimental material available, terrestrial life. Several crucial areas of study have been identified for extensive investigation from which first principles can be discerned and applied to the formulation of a theory for the origin and early evolution of life. Two approaches are adopted for studying biogenesis and biological evolution: one is to posit plausible models for relevant mechanisms, processes, and environments and test them either experimentally or by the use of computer simulations; the other is to identify early events and their evolutionary context in contemporary organisms since they are, in fact, repositories of information *concerning what took place during the evolution of life.*

W80-70638 **192-55-69**
Ames Research Center, Moffett Field, Calif.
BIOLOGICAL AND BIOCHEMICAL ASPECTS OF ECOSYSTEMS
H. P. Klein 415-965-5094

The objective is to define the parameters affecting the behavior of ecosystems, particularly how closure affects the composition and stability of ecosystems. These data will provide the background necessary to design life support systems capable of supporting *long term human activities in extraterrestrial environments.* The stability of ecosystems and the effects of closure on the properties of ecosystems will be studied using heterogeneous microbial populations. Plants will be grown utilizing synthetic and processed wastes and seedling growth will be correlated with the chemical and microbial properties of the waste solutions. The potentially harmful interaction between plants will be examined with the goal of identifying the volatile products that inhibit plant growth. The concept of a closed ecosystem will be mathematically modelled so that ecosystems of varying degrees of complexity may be examined for their behavior using any number of desired inputs as variables. This RTOP is being terminated. Portions of the work conducted in this RTOP will be transferred to 174-07 RTOPs.

Planetary Astronomy SR&T

W80-70639 **196-21-68**
Ames Research Center, Moffett Field, Calif.
DETECTION OF OTHER PLANETARY SYSTEMS
D. C. Black 415-965-5495
(790-40-11)

The objective of this activity is to develop a comprehensive program to detect other planetary systems. Near-term objectives include the completion of development and testing of a high-precision radial velocity meter and a Multichannel Astrometric Photometer (MAP) detector, as well as theoretical studies related to the detection of other planetary systems. The indicated increase in budget for FY-81 reflects anticipation of a budget augmentation for this program at that time. The objectives for the higher budget would include a significantly broader examination of alternative techniques and/or instrumentation for conducting a comprehensive, ground based program to detect other planetary

systems. The near-term approach involves funding to selected University researchers to complete the development and testing of the radial velocity and astrometric detectors. The theoretical work will be conducted in-house at Ames Research Center. It is expected that the objectives of the higher budget phase will be accomplished by means of both selected University and in-house activity.

W80-70640 **196-41-30**
Marshall Space Flight Center, Huntsville, Ala.
COMETARY OBSERVATION AND THEORY
C. R. ODell 205-453-3033
(188-41-51)

The objective is to obtain cometary spectra with intermediate spectral resolution between 350 to 820 nm, with emphasis on the longer wavelength, and to analyze rovibronic structure of the observed comets and spectra of comets in terms of a corrected resonance fluorescence mechanism. An Echelle spectrograph employing a S-20 fiber optics image tube with an F/2 Schmidt camera will allow a spectral resolution of approximately 0.5 Angstrom to be obtained on photographic plates. Standard data reduction by densitometry will be employed. A review of laboratory and cometary spectra will provide the initial suggestions to correct the resonance fluorescence mechanism (e.g., NH2).

W80-70641 **196-41-40**
Lyndon B. Johnson Space Center, Houston, Tex.
REMOTE SENSING OF PLANETARY SURFACES
A. E. Potter 713-483-5039

The objectives are (1) to develop a method for mapping silicate structures on the lunar surface using silicate reststrahlen bands in the thermal emission spectrum of the Moon. This technique complements information on Fe(+2) minerals obtained by reflection spectra in the 0.4-2.4 micron range; (2) to develop a multiplex method for rapid mapping of Fe(+2) minerals on the lunar surface using 0.8-2.4 micron reflectance spectroscopy, (current techniques obtain data for only a single site at a time); and (3) to measure the composition of comet dust as a function of distance of the comet from the sun. Far from the sun, ices of volatile materials should be found in the dust. Near the sun, nonvolatile materials, including silicates and Fe(+2) compounds should be found.

W80-70642 **196-41-50**
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED INFRARED ASTRONOMY
V. G. Kunde 301-344-5693
(196-41-54; 154-30-80; 154-20-80)

The scientific objective is to determine information on astrophysical objects, such as molecular clouds, interstellar lines, molecular and circumstellar components in stellar atmospheres, and planetary atmospheres from high spectral resolution ground based measurements in the intermediate infrared. A spectrometer system employing a Michelson interferometer, capable of operating at liquid N2 (77K), is being developed to meet the simultaneous requirements of high spectral resolution, a wide free spectral range and high sensitivity. An optical retardation up to 25 cm will provide an unapodized spectral resolution up to .02 cm -1 in the 400-2000 cm -1 range. A post dispersed detection system is being developed to reduce background noise from a warm telescope system and the atmosphere at the detector; thus allowing the multiplex advantage of the interferometer to be retained. The cooled instrumentation with the post-dispersed detection system, operating with a low background infrared telescope at a favorable infrared site, will allow maximum sensitivity to be attained for an interferometer system at a ground-based site. The sensitivity level for a measurement in the 1000 cm -1 (10 mu) region with a 122 cm diameter telescope, an integration time of 60 minutes and a spectral resolution of 0.2 cm -1 is approximately 5 x 10 -26 watts/cm 2/hz. The s/n level for Jupiter in the 1000 cm -1 region with the above system is approximately 7 for one minute integration time and full spectral resolution of 0.02 cm -2.

W80-70643 **196-41-51**
Goddard Space Flight Center, Greenbelt, Md.
RADIO AND RADAR PLANETARY STUDIES
J. K. Alexander 301-344-5461

The objective of this program is to obtain information on the nature, extent, and dynamical behavior of planetary magnetic fields, trapped radiation belts, and magnetospheres by studying the nonthermal radio emissions from the planets. The major approaches to this investigation are: (1) synoptic observations of Jupiter's decametric radiation via a global network of monitoring instruments, and (2) theoretical analysis of the generation and propagation of nonthermal radiation in a planetary magnetosphere. The Jupiter Monitor Network has provided unique data relative to the rate and stability of the magnetic field rotation, energetic particle trapping and precipitation processes and the physics of satellite plasma interactions in the magnetosphere, and correlative data both for other ground based observations and fly by in-situ measurements. The major emphasis in the coming year will be on analysis of ground based measurements obtained simultaneously with the flight radio measurements from the Voyager spacecraft and on detailed analysis of new merged data catalogs compiled from the long series of joint decametric measurements obtained by the NASA network, the University of Florida, the University of Texas, and the University of Colorado. This study, utilizing the most comprehensive data set ever assembled, will seek to understand the details of the beaming pattern of Jupiter's radio source based on the simultaneous observations of the planet from both Voyager spacecraft and the ground.

W80-70644 **196-41-52**
Goddard Space Flight Center, Greenbelt, Md.
IMAGING STUDIES OF COMETS
John C. Brandt 301-344-8701

The objective provides for the operation of a small high altitude observatory, Joint Observatory for Cometary Research (JOCR), for imaging research on comets and their interactions with solar radiation and the solar wind. This research is carried out with ground based images alone, or if suitable data from spacecraft such as Solar Polar Mission is available, with an appropriate combination of ground-based and in situ measurements. It should be noted that funding provides support for the operation of the observatory only; analysis of research results is funded by the interested Program Office. In addition, when suitable bright comets appear radio observations will be made at existing national facilities.

W80-70645 **196-41-54**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED INFRARED ASTRONOMY AND LABORATORY ASTROPHYSICS
M. J. Mumma 301-344-6994
(188-41-55; 198-10-01; 154-20-80)

The objective of the advanced infrared astronomy program is to study the molecular constituents of solar system objects (e.g. planetary atmospheres and comets) through observations of their IR line spectra, and so to further our knowledge about: (1) molecular abundances, (2) kinetic, vibrational, and rotational temperature distributions, (3) kinetic velocity shifts (winds), (4) vertical and spatial distributions, and (5) ambient gas densities, and to carry out comparative studies of these objects. The physical information we seek is contained in the intensity profiles of isolated spectral lines and can be obtained by inversion of the observed line shapes. The measurement of spectral line shapes has recently become a tractable problem at IR wavelengths, and line shapes can now be measured by infrared heterodyne spectroscopy. The approach is to develop and employ coherent detection line receivers for use in the infrared wavelength regions. The infrared front end has been built for use with gas lasers or semi-conductor diode lasers as local oscillators and HgCdTe photo-mixers. It feeds into a GSFC standard spectral line receiver which analyzes, displays, and outputs the spectral lines. Initial observations with this system have been from the ground, but it has been developed with an eye toward flights on the NASA C-141 and in space. Laboratory work on precise line frequency determinations and on pressure broadening effects is also carried out in support of the field experiment.

W80-70646 **196-41-67**
Ames Research Center, Moffett Field, Calif.
PLANETARY ASTRONOMY AND SUPPORTING LABORATORY RESEARCH
R. W. Boese 415-965-5501

The composition of planetary atmospheres and surfaces and the abundance, temperature and pressure of certain atmospheric constituents can be determined by spectroscopic observations from ground based and from airborne observatories. Such data are necessary for the preparation of valid model atmospheres, which are needed to evaluate the possibilities of life on the planets and to design systems for exploratory missions and for the preparation of evolutionary models of planetary interiors. The objectives of this work are to obtain, study and analyze spectroscopic observations of the planets and their satellites; to obtain and analyze, in the laboratory, spectra appropriate for valid interpretation of planetary observations; and to develop the analytical and computational techniques necessary to interpret planetary spectra in terms of real planetary atmospheres and surfaces. The objectives will be pursued by measuring, in the laboratory, basic molecular parameters such as absorption line and band intensities, absorption line half widths, vibration rotation interaction constants, and line pressure induced' shifts and absorption. The dependence of these parameters on pressure and temperature will be obtained by using long path gas cells, cooled and heated gas cells, and high resolution spectrometers and interferometers operating primarily in the infrared. Spectra of the planets and their satellites will be obtained by using airborne and ground based telescopes and will be analyzed to obtain information about the composition and structure of their atmosphere and the composition of their surface.

W80-70647 **196-41-71**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
OPTICAL ASTRONOMY
J. T. Bergstralh 213-354-2517

The overall objectives of the Ground Based Optical Astronomy task is physical study of planets and their satellites, by means of ground based observations, at visible and near infrared wavelengths (approximately 0.3 to 2.0 mu). This task consists of several subtasks: (1) Planetary Spectroscopy, to investigate the physical and chemical properties of the upper troposperes of Venus, Jupiter, Saturn, Uranus, and Neptune through high *resolution astronomical spectroscopy and spectrophotometry;* (2) Io Spectroscopy & Sodium D-Line Patrol, to investigate the physical state and bulk motions of the neutral sodium cloud associated with Io, through a variety of advanced high resolution spectroscopic techniques, and to investigate the temporal and spatial behavior of the Na D-line emission from the Jovian satellite Io (J-1) through a synoptic program of spectroscopic observations; and (3) Fabry-Perot Spectroscopy, to investigate the temperature and density of low energy thermal ions in Jupiter's magnetosphere. In addition to these primary subtasks, the Ground Based Optical Astronomy task provides limited operational support (equipment maintenance and set-up, observing assistance) at Table Mountain Observation (TMO) to programs supported from other sources. Among such programs are: lunar multispectral imaging; and outside observers from the academic community who use the TMO optical astronomy facilities from time to time.

W80-70648 **196-41-72**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
IR ASTRONOMY
R. Beer 213-354-4748

The objective of this program is to understand the physical and chemical state of planetary atmospheres by means of chemical and isotopic abundance analyses as determined by remote sensing methods in direct support of ongoing and planned planetary missions. The principal approach employed is that of high-resolution, near infrared (1-6 mu) astronomical spectroscopy using a Connes type Fourier spectrometer at the coude foci of large telescopes. At the present time, the instrumentation is undergoing substantial renovation and improvement prior to being installed on the new NASA 3 m IRTF on Mauna Kea, Hawaii.

W80-70649 **196-41-73**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DSIF RADAR ASTRONOMY
R. M. Goldstein 213-354-2654

The objective is to produce scientific results, in support of flight projects and possible flight projects, concerning planetary surface characteristics and topography, orbits and spins. The approach is to use the unique capabilities of the Deep Space Network to gather raw radar data with equipment developed under other work units. This raw data will then be processed under this RTOP to provide scientifically useful information about the target planet, asteroid, satellite, comet or ring system. Scientific data of value to the NASA flight projects and potential flight projects can be obtained with the transmitters, antennas, receivers and signal processing equipment of the Deep Space Network. Since these equipments are separately funded, a great savings is possible in obtaining the data. This work unit covers only the extraction of scientific information from the raw radar data. Altitude profiles of Mars will be attempted in early 1980. A belt of Northern latitudes will be examined, which includes the area of the Viking lander. Scattering properties of the surface will be measured. The reflectivity and polarization properties of at least one of the Galilean satellites will be observed.

W80-70650 **196-41-76**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMETS AND ASTEROIDS
R. L. Newburn 213-354-2319

Once the perihelion of any cometary orbit lies among the planets, brought there perhaps by stellar perturbations, the orbit begins to evolve rapidly compared to the age of the solar system. Once the perihelion reaches 3 - 5 AU the comet begins to change physically with great rapidity, typically becoming an inert, degassed body after approximately 1000 revolutions. Physical activity changes the orbit and orbital changes alter the physical activity. The current objectives are to investigate the dynamics and orbital evolution of several periodic comets and their end product, their attendant meteor streams, and to maintain a continuing program of groundbased physical observations of comets and the interpretation of these observations, giving emphasis to a quantitative understanding of the physical processes which give rise to the phenomena of nucleus, coma, and tails. The intent is to intercompare many comets in order to enhance the value of data taken on those few that become targets for space missions. Ground based observations will be carried out at Mauna Kea, Table Mountain, and other observatories using the best auxiliary equipment available at each. Dynamical work will begin with the computation of definitive orbits for comets with known associated, periodic, meteor streams. Using the orbits of these parent comets as initial conditions, computer simulations will follow the evolution of the meteor stream particles backward in time. The initial conditions and model variables will be iteratively adjusted until the simulation can reproduce the observed meteor shower data associated with each periodic meteor stream. Once correctly modeled, these computer simulations will be used to characterize the current size, shape and particle density of the various streams and to investigate the stream's age and evolution. These simulations would also provide useful predictions of future meteor showers.

W80-70651 **196-41-77**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLANETARY INFRARED IMAGING
R. J. Terrile 213-354-6158

The objective of this program is to provide high spatial resolution, ground based infrared images and spectra of Jupiter and Saturn in direct support of the Voyager mission. Jupiter will be observed in the 5 mu window into the deep atmosphere as a continuation of a very successful program to monitor Jovian weather patterns throughout the Voyager post-encounter period. Saturn will be observed at various infrared wavelengths in order to determine the suitability and philosophy of targeting the Voyager Imaging and Infrared Interferometer Spectrometer (IRIS) experiments. Observations will be made with an existing infrared imaging system at the Hale 5 meter telescope at 5, 8-14, and 20 mu. A Connes-type Fourier spectrometer is also expected to

be operational at Mauna Kea Observatory and will be used to provide high spectral and moderate spatial resolution data of Jupiter, Saturn and Titan. Simultaneous infrared imaging will also be attempted during spectroscopy runs.

W80-70652 **196-41-78**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EARTH BASED SOLAR SYSTEM OBSERVATIONS
M. A. Slade 213-354-3144

The work is aimed at investigating lunar, asteroidal, and planetary physical and chemical properties using a variety of ground based advanced techniques. (1) The Lunar multispectral imaging task utilizes the Silicon Imaging Photometer System (SIPS) to acquire multispectral data of various lunar regions. The basic objective is to correlate such spectral data with orbital and other ground based data sets, both as part of the La Jolla Consortium and as part of the PSI Basaltic Volcanism Project. (2) Near infrared lunar imaging task involves simultaneous 5600 A/2.2 mu imaging of the lunar near side surface with approximately 10 resolution, together with imaging of particular locations at other IR wavelengths. The near infrared region is used since there are diagnostic reflectance features present to distinguish among rocks, immature soils, and mature soils. (3) ALSEP/Quasar VLBI approach is the acquisition and processing of intercontinental Delta VLBI observation between lunar ALSEP transmitters and extragalactic radio sources (ERS). The ALSEP/Quasar observations employ a 3-antenna technique in which the differential phase is obtained with sufficient signal to noise ratio for processing at the Caltech/JPL correlator. The objectives are to tie the lunar orbit to the ERS reference frame, to test gravitational theories, and to measure various lunar bulk physical properties. The development of this technique is also important for eventually tying the planets to the ERS reference frame. (4) Photoelectric asteroid observations main objective is determination of asteroid rotation periods from their lightcurves. Occultation observations to measure asteroid diameters will be supported where possible. Available photometers at Table Mountain Observation will be used. (5) Io Volcano Patrol is a infrared photometry in the range 2.2 to 20 mu will monitor and map thermal anomalies over an extended time for correlation with volcanoes from Voyager data. Such observations will better characterize the state of current thermal activity on Io. (6) Planetary astronomy digital data analysis establishs a base of funding to permit IPL to provide support to planetary astronomers.

W80-70653 **196-41-80**
National Aeronautics and Space Administration, Washington, D.C.
GROUND BASED OPTICAL PLANETARY ASTRONOMY
William E. Brunk 202-755-3660

The objective is to increase our knowledge of the planets, their satellites, asteroids and comets through the use of astronomical observations made with telescopes and other optical instruments located at ground based observatories. The observations will be made throughout the visible and infrared portions of the spectrum. Reduction, interpretation, analysis, and publication of the data thus obtained are included as part of the objective. This activity will utilize the interest, experience and facilities of scientists outside of NASA to obtain data needed to support and supplement the planetary flight program. The program included under this RTOP covers observational studies of the planets, their satellites, asteroids, and comets in the optical and infrared portions of the spectrum made from ground-based observatories. The results of these studies are published in the open literature. The planetary science expertise and observational facilities required for this program are, in general, not available within the NASA centers.

W80-70654 **196-41-81**
National Aeronautics and Space Administration, Washington, D.C.
ASTRONOMICAL OPTICAL INSTRUMENT DEVELOPMENT
William E. Brunk 202-755-3660

The objective is to design, develop, and construct auxiliary instrumentation to be used for ground-based astronomical observations. The auxiliary instrumentation includes such items as cameras, photometers, spectrometers, interferometers, etc. The scientific return that can be obtained under RTOP 196-41-80 is limited by the instrumentation available to the investigators. The actual level of scientific return possible from ground-based observations in the optical and infrared could be much higher if additional instrumentation is developed under this task when the magnitude of the development is too great to be considered as part of the research task. Upon completion, these instruments are used for research programs under RTOP 196-41-80.

W80-70655 **196-41-82**
National Aeronautics and Space Administration, Washington, D.C.
GROUND-BASED RADIO AND RADAR PLANETARY ASTRONOMY
William E. Brunk 202-755-3660

The objective is to determine planetary properties by observations from ground-based observatories at radio wavelengths. Both passive (radio) and active (radar) observations will be performed. The program will include the reduction, analysis, and interpretation of the observations. The approach will utilize the interest, experience, and facilities of scientists outside of NASA to obtain data needed to support and supplement the planetary flight program. The program included under this RTOP covers observational and the associated theoretical studies of the planets, their satellites, and other members of the solar system in the radio portion of the spectrum made from ground-based observatories. Both passive, radio astronomy, and active, radar astronomy, observing techniques are included under this RTOP. The results of these research programs are published in the open literature. The planetary science expertise and observational facilities used in this program complement those available within the NASA centers and the Jet Propulsion Laboratory.

W80-70656 **196-41-84**
National Aeronautics and Space Administration, Washington, D.C.
LABORATORY SUPPORTING STUDIES (ASTRONOMY)
William E. Brunk 202-755-3660

The objective is to obtain laboratory data required for the analysis and interpretation of planetary observations made from the vicinity of the Earth. The data obtained will be of two types: (1) detailed study of gases and other materials known to exist on a planet, and (2) study of the properties of many possible materials to try to explain unidentified features detected in planetary observations. The data obtained under this program will be published as well as being used directly in the interpretation of new observations. Principal investigators on tasks under RTOP 196-41-80 frequently find that there is insufficient laboratory data on the spectra of the molecular constituents they are observing. Needed are data for specific molecules at conditions and wavelengths not normally encountered in laboratory studies. It is therefore necessary to obtain the needed data using specialized very long path absorption cells at a range of temperatures and pressures.

W80-70657 **196-41-85**
National Aeronautics and Space Administration, Washington, D.C.
THEORETICAL PLANETARY ASTRONOMY
William E. Brunk 202-755-3660

The objective of this activity is to provide theoretical support for the planetary astronomy program by predicting what data should be observed and by explaining the observational results, both predicted and unexpected. The program also involves the integration of observational and laboratory results from many sources to provide an explanation of planetary phenomena. Thus, this program provides an important link between the observational and laboratory programs and an understanding of the planets. Based on prior knowledge of the planets and existing physical laws, programs are undertaken to predict the observational data on the planets. As an example, theoretical atmospheric spectra are generated using assumed knowledge of the planetary atmospheric constituents, the spectral effects produced by a scattering atmosphere containing aerosols, and the dispersion of

the observable spectra. Comparison of the observed spectra with the theoretically calculated spectra tests the assumptions used in the theoretical calculations.

Life Sciences SR&T

W80-70658 **199-01-01**
Ames Research Center, Moffett Field, Calif.
CARDIOVASCULAR DECONDITIONING
H. Sandler 415-965-5744

The overall goal of this program is an understanding of the cardiovascular changes that regularly occur with space flight. Specific aims are to: (1) define the impact of changes on present and future crew and passengers; (2) develop methods for predicting deconditioning susceptibility; (3) provide appropriate countermeasures for susceptible iindividuals; and (4) provide the background for development and implementation of space flight experiments. To accomplish these goals, ground based studies on both human and animal subjects will be carried out. Specific activities will include bed rest studies in humans and total immobilization in animal models; the development of predictive indices for deconditioning susceptibility, including detection of latent disease and its effects on tolerance to space flight induced stresses; and tests of procedures, devices and drugs to prevent and counteract deconditioning. Results should lead to a better understanding of the mechanisms of cardiovascular deconditioning and improved monitoring of critical variables to provide guidelines for safety decisions before, during the after flight. Impact will be greatly improved flight safety, access of a broader segment of the population to space flight, and use of the weightless environment to expand our understanding of cardiovascular function.

W80-70659 **199-03-01**
Lyndon B. Johnson Space Center, Houston, Tex.
MEDICAL SELECTION CRITERIA
J. Degioanni 713-483-4021

The NASA JSC Space and Life Sciences Directorate performs medical evaluations of applicants for positions as Pilot Astronauts, Mission Specialist Astronauts, and Payload Specialists. The JSC Space and Life Sciences Directorate, in cooperation with the Director for Life Sciences, NASA Headquarters, provides selection officials with medical recommendations regarding the applicants. The personnel, facilities and equipment necessary to perform the medical evaluations of applicants for positions as shuttle crewmen exist at JSC. The JSC Space and Life Sciences Directorate inhouse capability, supplemented by the consultants, is used to medically evaluate applicants for positions as astronauts and used to examine and medically certify Payload Specialists for spaceflight as required. The objective of the medical evaluation process - as it applies to space crew selection - is to identify those individuals who have the ability to adapt to and work in the space environment. The medical evaluation of astronaut applicants is designed to ensure the selection of astronauts with maximum career longevity and to identify those applicants who by current standards can be classified as having no unacceptable potential medical risk factors. The medical evaluation process also serves as a model against which subsequent astronaut selections can be more effectively conducted.

W80-70660 **199-05-01**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE MOTION SICKNESS
J. L. Homick 713-483-5457

Manned space flight to data has demonstrated that space motion sickness (zero-g sickness) can be unpredictable and variable among individuals. A significant observation is that in individuals who do experience this problem, symptoms can persist through the third, fourth, or fifth day of flight. Thus, on short duration shuttle flights, a major portion of mission time could be spent with some crewmen who are not operating at maximum efficiency. The research program outlined by this RTOP is directed specifically toward resolving the problem of space motion sickness. An integrated program of basic and applied research on humans and animals will be conducted with four major objectives or end-products in view. These are: (1) a complete understanding of the causes of this syndrome in zero-g; (2) criteria for accurately identifying, prior to space flight, individuals susceptible to space sickness; (3) satisfactory methods for the prevention of symptoms; and (4) effective methods for the treatment of symptoms when they occur.

W80-70661 **199-07-01**
Ames Research Center, Moffett Field, Calif.
BONE/MUSCLE ALTERATIONS
D. R. Young 415-965-5549

Losses of bone mineral, muscle mass, and muscle strength have been observed in crew members exposed to weightless space flight. The losses have not been of clinical concern, but the basis for the alterations has not been explained adequately and the consequences for passengers and crew members in future long duration space flight have not been assessed. The goals of this RTOP are to provide the ground-based program and implement the future flight experiment program required to clarify the mechanisms producing musculo-skeletal alterations during space flight, to determine remedial countermeasures for the prevention of alterations, and to provide operational guidelines for crew safety. Solution of the musculo-skeletal problem area will be based upon recognition of operant physiologic mechanisms as they are altered by space flight, the extent and manner in which those changes could impair tolerance for long duration space flight, and the development of techniques for minimizing potential physiologic limitations. Animal models and human volunteers will be studied under hypodynamic and hypergravic conditions. Improved methods for the assessment of bone/muscle alterations will be established. Countermeasures will focus upon skeletal loading, pharmacologic intervention studies, and induced electrical events in bone. Flight experiment programs will be identified.

W80-70662 **199-09-01**
Lyndon B. Johnson Space Center, Houston, Tex.
BLOOD ALTERNATIONS (INFLUENCE OF SPACE FLIGHT ON THE BLOOD AND BLOOD-FORMING TISSUES)
S. L. Kimzey 713-483-4086

The most significant effect of the space flight environment observed relative to the blood and blood-forming tissues in man has been a consistent reduction in the circulating red blood cell mass during the flight interval. The variations in the magnitude of the loss in individual crewman and the complicated postflight recovery kinetics suggest a complex relationship between the red cell mass loss and the duration of the exposure to weightlessness. This anemia of space flight was frequently accompanied by a reduction in plasma volume, apparently occurring early in the mission and sustained throughout the flight. Other, more subtle, effects have been observed with respect to the function and structure of red blood cells and of lymphocytes, and in the concentration of some plasma proteins. The major emphasis of this research program will be to address questions relative to the regulation of blood volume during space flight and the causes of its apparent failure. The primary objectives will be to elucidate the mechanisms and etiology of the alternations in red cell mass and plasma volume and to determine the significance of these changes in limiting man's (both astronaut and non-astronaut) participation in space flight activities associated with the shuttle program.

W80-70663 **199-11-01**
Ames Research Center, Moffett Field, Calif.
PREFLIGHT DETECTION OF DISEASE
A. D. Mandel 415-965-5061

During the Apollo and Skylab programs a number of inflight infections occurred including upper respiratory infections, viral gastroenteritis and skin infections of microbial and fungal origin. In addition, there were other inflight disease events in which the clinical symptoms were highly suggestive of upper respiratory infections. During one of the Skylab missions, two crew members who were preflight carriers of Staphylococcus aureus, subsequently developed inflight illness caused by these organisms.

The objectives of this program are to develop measures for the rapid preflight detection of infectious disease, and procedures which will minimize the probability of an inflight infectious disease event. Current laboratory diagnostic procedures for the identification of infectious agents will be studied in order to develop modifications which will decrease the time interval between sampling and identification of the infectious agent. As an aid to preflight disease detection the application of instrumentation to the antigen-antibody reaction will be investigated. The preflight disease detection methods will be verified by clinical studies and a program will be developed to apply these findings to eliminate or minimize the probability of inflight infections.

W80-70664 **199-13-01**
Lyndon B. Johnson Space Center, Houston, Tex.
FLUID AND ELECTROLYTE CHANGES
Carolyn S. Leach 713-483-4086

Body fluid compartment shift occur in early exposure to weightlessness. These changes are complicated by losses in electrolytes (sodium, potassium, calcium, phosphorus, magnesium and chloride) occurring at a slower rate over mission duration which further influence fluid distribution. Hormonal responses are elicited to counteract these changes. The purpose of this program will be to study these changes and their effect on man's (astronaut and non-astronaut) ability to function in space. Results of the investigations in this RTOP will provide an understanding of the physiological and biochemical effects of weightlessness and rationale for nutritional and/or other countermeasures for use in future space flight missions. The information gained from exposure of man to weightless flight for periods approaching 3 months has shown that fluid and electrolyte metabolism has been altered in all crewmen studied. It is apparent that the changes experienced are multiphasic and are caused not only by the weightless environment but also by conditions related to the perparation for flight, the activity during flight, and the recovery procedures.

W80-70665 **199-15-01**
Lyndon B. Johnson Space Center, Houston, Tex.
THE MONITORING AND MAINTENANCE OF CREW HEALTH
W. C. Alexander 713-483-2986

This RTOP addresses the monitoring and maintenance of health of shuttle crewmen. Health is defined as the state of the organism when it functions optimally without evidence of disease or abnormality. Health, therefore, implies not only the absence of disease, but a positive concept in which normality has quantitative and definable boundaries. The objectives of this RTOP are to: define health in relation to the space environment; develop the procedures and equipment necessary to monitor health; determine and develop appropriate countermeasures to maintain health; and develop flight experiments to support the aforementioned objectives. The end products will be: (1) a set of criteria which describe health within the context of normal adaptative responses to weightlessness; (2) a set of procedures and hardware which will permit ground-based personnel to detect changes which violate the criteria established in (1); (3) procedures and/or equipment necessary to counteract changes caused by weightlessness if these changes are considered detrimental to crew health; and (4) inflight potential experiments. A four-year program which includes reviews, checkpoints, and parallel as well as sequential activities is defined. Indepth reviews of current efforts are planned to assure they support the basic problem addressed by this RTOP.

W80-70666 **199-17-02**
Ames Research Center, Moffett Field, Calif.
HUMAN BEHAVIOR AND PERFORMANCE
R. M. Patton 415-965-6602

Manned space missions require high levels of human performance in unfamiliar and stressful environments. Future missions will involve crew members, scientist passengers (chosen for their scientific and technical expertise, and not trained as career astronauts), and ultimately people from the population at large. Because of the high cost of these missions, and the high value of their successful completion, every effort must be made to maximize the probability of successful performance by all crew members and passengers. The objective of this RTOP is to develop selection, training, performance monitoring and corrective procedures that are appropriate to personnel on space missions. Individual and group performance will be studied to determine what characteristics of the individual and the situation lead to effective performance and adjustment in simulations of space missions. Selection and training procedures will be developed to identify good candidates for space flight, and to train them in minimum time. Corrective procedures will be developed to deal with possible cases of performance breakdown in space. The product of this work will be a selection/training/monitoring system suitable for application to space missions.

W80-70667 **199-19-01**
Lyndon B. Johnson Space Center, Houston, Tex.
DEFINITION OF PHYSIOLOGICAL DESIGN REQUIREMENTS
J. M. Waligora 713-483-5457

Physiological design requirements are quantifiable limits within which are assured some predictable level of physiological performance. Such limits have been defined and used for each of our manned spacecraft programs but they have not been fixed. They have evolved from program to program and in all cases they have been referenced to assumed conditions as to the subject population, length of exposure, and a basic null hypothesis as to effects of zero-g. In the orbiter program and in manned programs that will follow from it, some of these assumed conditions will no longer apply. Defining and maintaining applicable physiological design requirements will require research in several specific areas. In the shuttle era we will be dealing not with well conditioned relatively young pilots but with a broad population of men and women ranging in age to 65 years. An effort is required to define the response of this population. The vast majority of data collected on physiologic response to environmental stress has utilized young male college students and military recruits. The physiologic responses to spaceflight as demonstrated in Skylab and bedrest studies may have indirect effects on physiological response to environmental stresses.

W80-70668 **199-21-02**
Ames Research Center, Moffett Field, Calif.
SUPPORTING BIOMEDICAL RESEARCH
D. D. Feller 415-965-5251

The objective of this RTOP is to determine the process, time course and biomedical consequences of prolonged stays in weightlessness simulated by hypokinesia, confinement or other means. This research program will result in the identification of prolonged space flight problems, the selection and planning of flight experiments to confirm the existence and explain the mechanisms causing these problems, and recommendations for preventive or corrective measures to ensure the safety and tolerance of man in prolonged missions. The program will include both animal and human studies. Skylab data and data from Cosmos flight experiments will be compared to those obtained from animals and humans in chronic stress situations and in weightlessness simulation (bed rest, inactivity) to determine the physiological cost of man's adaptation to prolonged space flight and the time course of such adaptation. Particular emphasis will be placed on mechanisms regulating hormone changes that accompany such general adaptation, on changes in gravity-sensing tissue receptors, on nutritional and energy requirements and metabolism during prolonged missions. Man's degree of adaptation will be measured by this ability to respond to unexpected demands such as infection, drugs and toxic materials, sleep deprivation, pain, heat, cold, and to other emergencies such as tissue repair.

W80-70669 **199-23-01**
Lyndon B. Johnson Space Center, Houston, Tex.
SUPPORTING BIOMEDICAL RESEARCH/JSC
W. H. Shumate 713-483-4461

The objective is to support the conduct of biomedical research to insure man's well-being and his capability to function properly during extended space flight and subsequent reentry into the one-g environment; and provide to the biomedical laboratories

within the Medical Science Division a broad base of support in the management and statistical analysis of data resulting from special research projects, such as bedrest studies, and continuing research projects, such as longitudinal studies of flight personnel. This RTOP collates those JSC research tasks which either do not specifically lend themselves to any of the problem-oriented RTOPs or conversely contribute and/or support many of these RTOPs. Research studies supported by this RTOP are in general those that include multiple disciplines, laboratories, and RTOPs within the division and which cannot be assigned specifically to a single task within one RTOP.

W80-70670 **199-25-01**
Lyndon B. Johnson Space Center, Houston, Tex.
CLINICAL USES OF SPACE AND CLINICAL APPLICATION OF SPACE TECHNOLOGY
B. T. Saverland 713-483-5457

This RTOP provides a mechanism whereby investigations, studies, and research can be conducted to establish and pursue a logical, directed program for the purpose of exploring and identifying uses of the space environment in medical research and also to apply space related technology to the solution of medical problems on Earth. This activity within the OSS SR&T differs from similar activities in other offices in both approach and scope. The approach is directed primarily toward making the medical community aware of the opportunities to conduct research in the STS Program and to encourage their exploration of clinical medical uses of space. The scope is restricted to medical research and initial studies to explore and define concepts that can be developed to the point where they can be assigned to appropriate RTOPs within the applications area.

W80-70671 **199-27-01**
Lyndon B. Johnson Space Center, Houston, Tex.
CLINICAL MEDICAL CREW SUPPORT
S. A. Bergman, Jr. 713-483-4731

It is essential that future spaceflight passengers and crewman be provided access to quality health care while inflight. Clinical support systems have been used on all prior flights which involved man. Examples of the type of clinical support range from the rather limited Mercury, Gemini and Apollo medical kits to the inflight medical support system developed for Skylab. The objective of this RTOP is to assure that adequate clinical support systems (hardware and software) are available for Shuttle passengers and crew.

W80-70672 **199-41-07**
National Aeronautics and Space Administration, Washington, D.C.
SPACE BIOLOGY
Thora W. Halstead 202-755-3773

The goal of space biology is to increase understanding of biological processes as they are affected by the unique environment of space. To achieve this, the past and present effects of gravity on biological systems are investigated and gravity is used as a tool to better understand gravity's role in terrestrial life and environment, biological evolution and life in space. Specific objectives are to: (1) investigate and identify the role of gravity in plant and animal cellular processes, embryonic development, morphology and physiology; (2) identify the mechanisms of gravity sensing and transmission of gravity perception information within both plants and animals; (3) identify the interactive affects of gravity and other stimuli (e.g., light) and stresses (e.g., vibration) on the development and metabolism of organisms; and (4) extend the limits of knowledge about plant and animal growth and metabolism to provide for longterm survival and multigeneration reproduction of life in space.

W80-70673 **199-43-01**
Lyndon B. Johnson Space Center, Houston, Tex.
ECOLOGY/ENVIRONMENTAL EFFECTS
D. S. Nachtwey 713-483-3419

The objective of this program is to investigate and define the extent of the impact on human health and the biosphere that may be caused by increased ultraviolet radiation resulting from stratospheric ozone layer reduction by space transportation systems (STS) operations and other potential NASA activities. It has been calculated that emissions from space shuttle booster rockets will reduce the stratospheric ozone layer and allow an increase in biologically damaging ultraviolet radiation (UV-B, 290-320 nm) to penetrate to the earth's surface. Factors other than shuttle operations may also contribute to an increased UV-B via reduction of the ozone layer: high altitude aircraft emissions, halocarbon refrigerants and aerosols propellants, nuclear weapons detonations, nitrogen fertilizer usage, heavy lift launch vehicle emissions, etc. Because of the multiple causes for potential ozone reduction and the various government agencies concerned, the research program represented here constitutes only a part of a more comprehensive, longterm, interagency program that is needed to provide definitive data on the potential biological impacts from all sources. Although such a long term interagency program has not yet been established, the NASA program presented here lays very valuable groundwork for such an interagency program when and if it should be established.

W80-70674 **199-45-01**
Lyndon B. Johnson Space Center, Houston, Tex.
RADIATION EFFECTS AND PROTECTION
C. M. Barnes 713-483-3419

The current research program is designed to investigate and measure the biological effects of exposure to the space radiation environment with the primary objective of assuring the safety of man in flight. Radiation protection for personnel in space flight is dependent upon (1) knowledge of the radiation environment and ability to measure it precisely; and (2) knowledge of biological effects and determination of an acceptable risk level of exposure. This RTOP addresses these areas. The basic effort of the radiation effects research program must be the determination of the biological effects of those components or factors of the space radiation environment that are unique and for which no prior ground-based experience is applicable. There is emphasis, therefore, on a continuing investigation of the response of biological systems to high energy, heavy, multicharged (HZE) particles. This area presents the greatest potential hazard to long-duration manned spaceflight and the level of hazard must be adequately characterized before extended activity at geosynchronous altitudes and long term, deep-space penetration manned missions can occur. In general, this effort consists of exposing experimental animals to various radiation regimens simulating the space radiation environment. The effects observed are compared with the known response of animal and man to provide an estimation of the human response to these potential space radiation exposures. Emphasis will be placed upon acquisition of data regarding tumorogenic, lenticular, and central nervous system effects of proton and electron radiation.

W80-70675 **199-51-04**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADVANCED TELEOPERATOR TECHNOLOGY DEVELOPMENT
A. K. Bejczy 213-354-4568
(506-19-35)

The objectives are to develop technical information about remotely manned systems (RMS) or teleoperators so that shuttle based orbital missions requiring the use of such systems can be planned and implemented with the required reliability, performance, and economy. Specific objectives are to identify requirements, develop conceptual designs and breadboards, and determine the complementary roles of man and machine in the operation of RMS and teleoperators including time delay requirements with emphasis on supervisory control. The approach is through experimental studies identifying the scientific and operational mission requirements and developing the resultant necessary RMS or teleoperator functions. From the implied capability requirements for man and machine, the necessary technology developments for teleoperator systems and subsystems are derived. Required developments are defined and implemented experimentally using breadboard set-ups. The experimental studies will give insight into the functions to be performed by man or machine or both for remote explorations and operations. Function allocations will be made between man and machine for various communication time delay requirements, so that optimum system

performance can be achieved and critical technology development requirements can be identified. New concepts of teleoperator systems and subsystems will be developed and breadboard when appropriate and related feasibility studies will be conducted. Man-machine system performance evaluations will be conducted. Emphasis is given to the concept of shuttle-based flight experiments to give the work focus. The tasks are aimed at developing technology advancing teleoperators toward semi-autonomous operations. The major FY-80 objectives are: (1) completing development and evaluation of force-reflecting hand controller; (2) extension of voice command for TV control; (3) development of integrated control station; (4) continuation of sensor aided control experiments with distributed m/m control; (5) development of manipulator/TV control coordination; and (6) starting installation of a connected speech recognition system.

W80-70676 **199-53-01**
Lyndon B. Johnson Space Center, Houston, Tex.
MAN-MACHINE ENGINEERING REQUIREMENTS FOR DATA AND FUNCTIONAL INTERFACES
J. L. Lewis 713-483-4966

The objective is to move toward quantification of man-machine engineering data, both on the ground and in flight; to continue to pursue state-of-art technology and to advance that technology for the purpose of creating more effective and efficient man-machine interfaced for manned spacecraft; and to improve techniques of man-machine engineering design so that innovative steps may be taken toward creating better crew interfaces in future vehicles. The approach is to implement a series of continuing tasks to identify and implement workable instrumentation packages for acquiring quantitative man-machine engineering in one-g, simulated zero-g, and actual zero-g; to continue those efforts currently defined that lead toward definitive design requirements for use as inputs to the design performance lab; and to pursue feasibility studies of promising new crew interface items.

W80-70677 **199-71-01**
Ames Research Center, Moffett Field, Calif.
ADVANCED EXTRAVEHICULAR SYSTEMS
P. D. Quattrone 415-965-5733

The objective is to advance the technology base for advanced extravehicular systems required to support long term manned space missions. The advanced extravehicular systems must provide for extended EVA capability. This RTOP program will emphasize: improved hardware performance; increased hardware and system life; and reduced EVA equipment and payloads design, manufacturing, maintenance, and operations costs. The technology areas associated with protection of an EVA astronaut will be pursued under this RTOP. This includes: development of efficient 8 psig suit components that provide for greater mobility; development of advanced liquid cooled/vent garments to provide improved thermal comfort and control; development of regenerative portable life support subsystems to eliminate or reduce the expendable requirements associated with CO2 and thermal control; and development of portable life support components.

W80-70678 **199-73-01**
Ames Research Center, Moffett Field, Calif.
ADVANCED LIFE SUPPORT SYSTEMS
P. D. Quattrone 415-965-5733

The objective of this program is to advance the technology base for regenerative life support systems required to support long-term manned space missions. The regenerative life support processes must provide a more complete system closure (reduction of expendables). The subsystem functions to be investigated and developed include the following: air revitalization; atmospheric supply and composition control; water reclamation; waste management; and advanced food technology. Specific life support subsystem technology areas will be investigated (feasibility and/or development) and subsystem concept designs will be generated. This RTOP will be directed toward advancing the technology and/or hardware development status for advanced life support subsystems, and will result in achieving a technology base (research and hardware development) for subsystems that have the characteristics of low maintenance, high reliability, and long life.

W80-70679 **199-91-02**
Ames Research Center, Moffett Field, Calif.
JOINT US/USSR BIOLOGICAL SATELLITE PROJECT (COSMOS 79 AND 81)
K. A. Souza 415-965-5735

U.S. biological & radiation physics experiments were flown on Soviet spacecrafts Cosmos 782 (Nov. 1975) & Cosmos 936 (Aug. 1977). A third joint mission is scheduled for flight during September 1979. At the 8th & 9th meetings of the Joint US/USSR Working Group for Space Biology & Medicine, the U.S. was invited to participate in a series of spaceflights using primates as experimental subjects. The first of this series will be launched in mid-1981. The objectives are (1) to determine the effects of spaceflight on a wide range of biological specimens; (2) to use hypogravity as a tool to study fundamental problems in biology which cannot be solved on the ground; (3) to use biological subjects as surrogates for man to study problems encountered during spaceflight common to man & animals; (4) to measure the radiation environment inside & outside the spacecraft and evaluate shielding techniques; (5) to evaluate countermeasures to the deleterious effects of spaceflight; (6) to stimulate an exchange of scientific information related to spaceflight between U.S. & U.S.S.R. scientists. U.S. experiments are proposed in response to the U.S.S.R. invitation. The experiments are reviewed in the U.S. & U.S.S.R.; those selected are developed for flight, flown, results analyzed, & final reports prepared.

W80-70680 **199-97-01**
Lyndon B. Johnson Space Center, Houston, Tex.
INTERDISCIPLINARY RESEARCH
Lawrence F. Dietlein 713-483-3503

The Life Sciences Directorate at Johnson Space Center is responsible for the development of a comprehensive biomedical research program in support of manned space flight. This broad, multidiscipline mandate to acquire hew knowledge is directed toward the acquisition of definitive data regarding the effects of the space environment on life systems in order to define the critical physiological and psychological variables which must be integrated into the overall considerations of spacecraft designers and mission planners. The objective of the interdisciplinary research RTOP is to provide flexibility in the accomplishment of this goal.

W80-70681 **199-97-02**
Ames Research Center, Moffett Field, Calif.
INTERDISCIPLINARY RESEARCH
H. P. Klein 415-965-5094

The objectives are to provide support for preliminary investigation of various alternative life sciences research and technology efforts which might ultimately become part of an approved programmed RTOP.

Solar Terrestrial Spacelab Payload Definition

W80-70682 **356-36-01**
Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE/TETHERED SATELLITE SYSTEM (TSS) SCIENCE DEFINITION AND SUPPORT ACTIVITIES
Jay H. Laue 205-453-0163

The shuttle tethered satellite system (TSS) will provide the means to deploy subsatellites from the orbiter at distances up to 100 km, maintain them in a flight profile, and reel them back into the orbiter cargo bay. The objective of this activity is to continue the Phase B definition activities for the TSS and to provide scientific requirements for upper atmospheric exploration, electrodynamic tether applications, gravity and magnetic field mapping scientific experiments which will influence the design of the TSS. These scientific requirements will enable the Phase

B contractors to accurately define the systems for realistic scientific missions.

W80-70683 **356-38-01**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED MISSION STUDY - SOLAR X-RAY PINHOLE SATELLITE AND LONG FOCAL LENGTH CORONAGRAPH
Joseph R. Dabbs 205-453-3430

Hard X-ray imaging (10 - 100 keV) from solar flares will contribute not only to knowledge of the sources directly associated with the chromospheric manifestations of flares, but will also help explore the corona. A solution to the problem of achieving significantly better angular resolution for hard X-rays lies in the 'pinhole satellite' concept. An equally important use of the pinhole satellite will be its application as an external occulter for coronagraph observations of the solar corona. Previous feasibility studies have investigated alternative stabilization techniques and preliminary optical systems design for a long focal length coronagraph which will be flown on an early spacelab mission utilizing a boom-deployed occulting mask. The next evolutionary step beyond the coronagraph is to actually implement partial (or full) subsystems of the X-ray pinhole camera system in addition to the coronagraph. An example of such a partial system would involve X-ray detector arrays of smaller size which could image regions of the sun. Once the systems have been developed and verified the step to a full free flying system with separations on the order of 1 km or greater can be undertaken with greater confidence.

Astrophysics Spacelab Science Payload Definition

W80-70684 **358-41-06**
Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF SPACELAB PAYLOADS FOR INFRARED ASTRONOMY (SPIRA)
L. S. Young 415-965-6546
(506-19-15; 506-18-11; 506-25-21)

The objective of this RTOP is to define and develop infrared astronomy facilities and multi-user instruments for Spacelab payloads. Facilities include cryogenically-cooled infrared telescopes which can accommodate multiple focal plane instruments. These facilities and instruments, when combined with shuttle and Spacelab flight and ground equipment, provide space borne observations to serve infrared astronomers during the shuttle era. A design study of the shuttle infrared telescope facility (SIRTF) was performed and its shuttle/Spacelab accommodations and operations were studied. A design optimization study is being performed to apply the design techniques learned from ongoing infrared projects. A recent study of the scientific instruments was performed by the SIRTF focal plane instruments and requirements science team (FIRST) and the instrument accommodations are being thoroughly studied based on the new instrument definitions. The design optimization study is being supported by another team of astronomers called the SIRTF science working group. Technology development and demonstration are being performed under this and related RTOPs. This RTOP also provides support for analysis of data from the Spacelab 2 Small Helium-cooled Infrared Telescope particularly for atmospheric contamination measurements around the shuttle.

W80-70685 **358-46-01**
Goddard Space Flight Center, Greenbelt, Md.
HIGH ENERGY ASTROPHYSICS MULTI-USER INSTRUMENTS/FACILITIES
Curtis Stout 301-344-8566

The objective is to define and develop the scientific and technical basis for a number of multi-user instruments/facilities designed to make observations of extraterrestial X-rays, gamma rays, and energetic particles which encompass the field of high energy astrophysics. The availability of the shuttle with its capability for orbiting large facility class instruments provides the scientific community with the opportunity to explore this entire range of the electromagnetic spectrum. It is proposed to study several candidate instrument/facilities over the next several years for launch in the 1980's. A selection will be made from the following list: (1) large area modular array of reflectors, (2) pinhole camera subsatellite, (3) high resolution scanning spectrometer, (4) gamma-ray spectrometer, and (5) superconducting magnet facility.

W80-70686 **358-78-01**
Goddard Space Flight Center, Greenbelt, Md.
ASTROPHYSICS SPACELAB PROJECT ATD AND SYSTEM STUDIES
Robert C. Weaver 301-344-7297
(356-78-01)

The objective of the shuttle spacelab project ATD and system studies is: (1) to develop instrument design guidelines for experiments to be conducted on Spacelab in the discipline of astrophysics; (2) to define requirements and interfaces for subsystems necessary to support astrophysics experiments; and (3) to define data system requirements for SSPP payloads in the astrophysics disciplines. Within the disciplines of astrophysics, the need for effective communication between the shuttle spacelab payloads project and the user community in the area of mission instrument control and data handling is required.

W80-70687 **358-78-01**
Marshall Space Flight Center, Huntsville, Ala.
SCIENCE AND APPLICATIONS SPACE PLATFORM CONCEPT AND ACCOMMODATION ANALYSIS
James O. Ballance 205-453-3430

The objectives are to establish firmly the payload accommodation requirements for a space platform system and to determine the advantages of disadvantages to the science program. To accomplish these objectives, the following tasks will be performed: (1) the payload accommodations and scenarios developed by the Marshall Center study will be reexamined and a sensitivity analysis of the most critical requirements will be made; and (2) alternate operational concepts will be explored to assess the impact on the number of instrument carriers, platforms, etc.

W80-70688 **358-78-60**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STUDY OF LARGE DEPLOYABLE ANTENNAS FOR ASTRONOMY APPLICATIONS
Paul N. Swanson 213-354-3273

The objective of this RTOP is to investigate the feasibility of large (10-30 m diameter) deployable parabolic reflectors for use in submillimeter and infrared astronomy. The capability of the space shuttle to orbit a large mass plus recent developments in composite materials and structural analysis open up the possibility of placing a submillimeter/infrared telescope of very large large collecting area in orbit. A submillimeter/infrared telescope in orbit is free from the gravitational problems which limit the maximum size of ground based reflectors and is also free from the partially opaque and variable atmosphere which presently limits observations to a few selected atmospheric windows. The approach, in conjunction with the Ames Research Lab, is to establish a set of scientific requirements for both the submillimeter and infrared regions and make an assessment of relevant current technology (in particular, military sponsored activities). The combination of the scientific requirements and the technology assessment form the basis for a competitively procured industry study on the feasibility of large deployable reflectors for submillimeter and infrared astronomy applications.

Solar Terrestrial Data Analysis

W80-70689 **385-36-01**
Goddard Space Flight Center, Greenbelt, Md.
ATMOSPHERE-IONOSPHERE-MAGNETOSPHERE INTERACTIONS
R.E. Hartie 301-344-8234

The basic objective is to study the observed properties of

the inner magnetosphere, ionosphere, mesosphere and thermosphere to identify and understand the physical and chemical processes operating in these regimes, emphasizing how they interact. This is achieved by processing, analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated, permitting the study of long term phenomena, comparison of data with new theories and models, correlative studies of data obtained from various satellites and ground base observatories, and the deposition of data in the National Space Science Data Center. The essential data to be used in this investigation include electron densities and temperatures, ion and neutral composition, neutral winds, ion temperatures and drifts, electric fields, magnetic fields, electromagnetic radiation and energetic particles of magnetospheric and ionospheric origin. These data are used to determine the various interrelated chemical, compositional, dynamical and energetic states of the inner magnetosphere, ionosphere, thermosphere and mesosphere and the transport and deposition of mass, momentum and energy in and between these physical regions. These basic properties and processes are then used to analyze specific geophysical phenomena such as: electric field induced ion drifts in the ionosphere and inner magnetosphere, chemistry and dynamics of mid and high latitude troughs, auroral substorms, ionospheric storms, Joule heating, PCA events, tidal and gravity waves, depletion and filling of plasmasphere, ionospheric plasma resonances, equatorial bubble formation, SAR Arcs, ring current decay, etc.

W80-70690 **385-36-01**
Ames Research Center, Moffett Field, Calif.
PIONEER 6-11 PLASMA DATA ANALYSIS
J. D. Mihlov 415-965-5516
(170-36-55)

This RTOP provides for analysis of solar wind plasma data from Pioneers 6 through 11. The solar wind proton and helium parameters, including proton temperature anisotropy, are obtained from the plasma analyzer data using least squares fitting computer programs. Gradients of solar wind parameters with heliocentric distance are determined using data from Pioneers 10 and 11. Solar wind plasma time variations are also correlated with scientific data from other spacecraft and with Earth-based observations to study the steady and dynamic characteristics of the solar plasma flow and the solar wind-geomagnetic field interaction. Data analysis and averaging programs are maintained. Data are supplied in various forms to co-investigators.

W80-70691 **385-36-01**
Marshall Space Flight Center, Huntsville, Ala.
MAGNETOSPHERIC DATA ANALYSIS
Charles R. Chappell 205-453-3036
(170-36-55)

The objective is to obtain an adequate understanding of the dynamics of low-energy plasma in the earth's magnetosphere through: (1) reduction and analysis of data from the Auroral Particles Experiment on ATS 6 in cooperation with the University of California at San Diego and UAH; (2) the analysis of the light ion mass spectrometer data from the NASA/DOD SCATHA satellite; (3) the laboratory simulation of plasma flow around different objects; and (4) the analysis of sounding rocket data on ionospheric temperature and dynamics.

W80-70692 **385-36-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MAGNETOSPHERIC PHYSICS: DATA ANALYSIS
R. W. Davies 213-354-4156

This work provides analysis and interpretation of scientific data from the OGO search-coil magnetometers, the Mariner and Pioneer vector helium magnetometers, and radio data from many deep space missions. Pioneer 10 and 11 vector helium magnetometer and OGO-5 and 6 search coil magnetometer data will be analyzed and interpreted to investigate the following topics: configuration of the interplanetary magnetic field and latitude and radial gradients in the solar wind; power spectra of the interplanetary magnetic field variations and their relevance to cosmic ray modulation; evolution of streams, stream-stream interaction regions, discontinuities and sector boundaries; energization of approximately 1 MeV protons at interplanetary shocks and within CIRs; the Jovian magnetic field, magnetopause structure, and magnetosheath compressional waves; ELF waves and wave-particle interactions in the earth's plasmasphere, magnetosphere and magnetosheath. Particular attention will be paid to the possibility of wave triggering by manmade emissions, such as power line harmonic radiation and VLF transmitter radiation. The work will be performed at JPL in collaboration with Caltech, UCLA, Univ. of Chicago, and other institutions. Radio scattering measurements of the solar wind will be made with the coherent, monochronomatic and point-source signals received from various deep space probes. These studies, made possible by recently developed techniques, will yield information on density fluctuations over a wider range of scale sizes and heliocentric distances than have ever been possible before. Extensive solar wind velocity measurements will also be made in the important acceleration region close to the sun.

W80-70693 **385-36-02**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS - SPACE PLASMA PHYSICS
J. K. Alexander 301-344-5461

The basic objective is to study the observed properties of the interplanetary medium and the magnetosphere and to identify and understand the physical processes operating in these regimes, including how they interact. This is achieved by processing, analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated, permitting the study of long-term phenomena comparison of data with new theories and models, correlative studies of data obtained from various satellites and ground based observatories, and the deposition of additional data in the NSSDC. The essential data to be used in this investigation include magnetic fields, plasma waves, energetic particles, plasma, and kilometric radiation. These data are used to determine the various dynamical and energetic states of the interplanetary medium and the magnetosphere, and the transport and deposition of momentum and energy within and between these physical regions. These basic properties and processes are then used in the study of specific geophysical phenomena such as interplanetary current sheets, energetic particle acceleration, and magnetic fields and plasma in the magnetosheath and the magnetotail.

W80-70694 **385-36-03**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS ATS-6 PARTICLE PHYSICS EXPERIMENTS
C. D. Wende 301-344-5602

The objectives are: (1) to complete the prime data analysis; including processing and interpretation, of experiment data from the ATS-6 spacecraft; (2) to provide for secondary data analysis by submitting analyzed and/or reduced data for archiving in the National Space Science data center; and (3) to publish in the scientific literature studies of observed phenomena.

W80-70695 **385-36-04**
Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLES AND PLASMA IN THE JOVIAN MAGNETOSPHERE
T. G. Northrop 301-344-8441

The objective of this study is to gain an understanding of the sources, sinks and dynamics of energetic ions and electrons in the Jovian magnetosphere. This work applies plasma theory and the theory of charged particle motion to data taken by Pioneers 10 and 11, and by Voyager. Included in the dynamics will be a study of the observed effects of the Jovian moons on the fluxes, and deduction of diffusion coefficients from these observations.

W80-70696 **385-38-01**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR PHYSICS DATA ANALYSIS AND OPERATIONS
Robert D. Chapman 301-344-5101

The objectives are: (1) to process, analyze and interpret experiment data from flight projects and to continue this work after the immediate fundings from project offices have terminated;

(2) to publish in scientific literature detailed studies of phenomena gathered over protracted periods of time which reveal long term features and correlation effects not evident during the prime data analysis; (3) to engage in multidisciplinary studies comparing experiment data from other satellites and/or ground based laboratories in order to investigate in fine detail fine structure, long term and secular efforts; and (4) to provide additional reduced, analyzed data for archive in the National Space Science Data Center.

Astrophysics Data Analysis

W80-70697 **389-41-01**
National Aeronautics and Space Administration, Washington, D.C.
DATA ANALYSIS
E. J. Weiler 202-755-3687

The objective is to obtain, reduce, and analyze data derived from or in direct support of space science experiments. The efficient exploitation of the observational capability afforded by modern instrument systems such as satellites requires the use of sophisticated computational facilities and techniques. Speed of computation, data storage requirements, and complexity of analytical techniques act as drivers in defining the overall requirements beyond those for the intial data transmission and pre processing. Archival storage and retrieval are important aspects related to future referral for additional analysis and cross correlation. The scientific return of experiments is enhanced to providing for non redundant data analysis and by providing for data augmentation to either confirm or expand the experimental results. The approach is to provide support for the processing and analysis of experimental data. This can be the primary mission objective or for extended analysis based on processed data. Provisions for expanding the number of investigators is made to allow wider participation in the space science program and injection of fresh or noval approaches. In addition, correlative observational progress are maintained to augment the data base and thereby provide new insights in the analysis and interpretation of the original data.

W80-70698 **389-41-01**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS: ASTRONOMY
J. M. Mead 301-344-8543
(188-41-51; 188-41-55)

The objective is to develop tools techniques which will facilitate and improve the reduction, analysis and understanding of astronomical data, primarily through the application of computers for managing large blocks of observational information obtained at all wavelengths for stars, galaxies and other extended objects. This objective is being carried out through the development of a Computerized Astronomical Data Retrieval System, which provides data searches and digital plots for specified catalog ID numbers, positions and other parameters. Building on the techniques developed for that system, a Merged infrared Catalog has been produced to provide IR fluxes and magnitudes for the brightest IR objects. Both data sets will be expanded by acquiring, checking out and fully documenting additional catalogs plus journal articles. A combined catalog of cool stars, variable stars and extended objects will be created to provide candidates for optical identifications of IR sources obtained to satellite surveys and for observing programs at long wavelengths. Other tasks in this RTOP include studies of the structure and evolution of pulsars, supernovae remnants, radio galaxies and quasars requiring radio observations obtained with very high angular resolution; analyses of spectrophotometric observations made by space-borne astronomical payloads in order to study mass flow from stars, interactions in close binaries, circumstellar and interstellar matter, and X-ray emitting galaxies; and the preparation of two books summarizing and evaluating observational and theoretical knowledge currently available about the physical state of O and B stars.

W80-70699 **389-41-01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EXTRAGALACTIC RADIO SOURCE MONITORING
R. A. Preston 213-354-6895

Information on the properties of extragalactic sources, principally quasars, will be extracted from very long baseline interferometry (VLBI) observations performed for geophysical and solar system studies. About 50 to 100 sources will be frequently monitored; 1000 - 1500 sources will be observed at least once. Careful instrumental calibrations will be made during all observations so that the fringe amplitudes may be properly interpreted (only fringe phase information is important for JPL's geodetic and astrometric studies). Single observations of sources allow compact VLBI components to be identified. Accurate positions of compact objects will be determined to allow optical identifications to be made. When all the observations of fringe amplitude for a particular source are compared as a function of baseline and hour angle of the observations, rudimentary information on the structure of an object can be obtained. Temporal variations in structure, total flux densities and spectra (13 and 3.6 cm) will be monitored. Such frequent VLBI monitoring of a large sample of compact excited objects would be too costly a task for only astronomical purposes.

W80-70700 **389-46-01**
Goddard Space Flight Center, Greenbelt, Md.
HIGH ENERGY ASTROPHYSICS DATA ANALYSIS
F. B. McDonald 301-344-8801

The objectives are (1) to process, analyze and interpret galactic, interplanetary, Jovian, and solar cosmic ray data from space flight experiments after the immediate funding project offices have ceased and for detailed studies of these phenomena involving multisatellite data sets; (2) to engage in multidisciplinary studies comparing experiment data from other satellites, deep space missions and manned missions such as Skylab as well as using ground based observations to study in detail a wide range of high energy astrophysics phenomena; (3) to further analyze the low energy gamma ray data from Apollo 17 and Apollo Soyuz; (4) to publish these results in the scientific literature; and (5) to make the data available to the National Space Science Data Center.

W80-70701 **389-46-01**
National Aeronautics and Space Administration, Washington, D.C.
HIGH ENERGY ASTROPHYSICS - THEORY AND DATA ANALYSIS
Albert G. Opp 202-755-8493
(188-46-56)

This program supports research in theoretical astrophysics and the continued analysis of data from spacecraft, ballons and rockets. It is intended to provide theoretical basis for the high energy astrophysics flight program. This program also provides funds for the continued analysis of astrophysical data beyond the official completion of the mission, and it provides funds for the analysis of data by investigators not originally associated with the principal investigator. The theory portion supports theoretical groups who investigated particle transport phenomena, plasma effects in astrophysical settings, theoretical gamma ray spectroscopy, modeling of X-ray sources and cosmology. Particle transport involves the study of the forces affecting charged particles as they emerge from the site of their creation, which could be a supernova, a pulsar or the sun, and traces their behavior as they diffuse through the galaxy and into the site of their observation. Plasma astrophysics investigations employ the concepts of fusion and geophysical plasma theory to settings such as pulsar magnetospheres, stellar flaring and gravitational collapse.

W80-70702 **389-46-02**
Goddard Space Flight Center, Greenbelt, Md.
SAS-2 DATA ANALYSIS
D. J. Thompson 301-344-5866

The objective of this work was to summarize the final results from the SAS-2 high energy gamma ray experiment. The SAS-2 results have been summarized in forms which allow easy

comparison with other wavelengths and thus provide a reference data base for comparison with future observations. Final data in appropriate form have been transferred to the National Space Science Data Center.

W80-70703 **389-46-03**
Goddard Space Flight Center, Greenbelt, Md.
THEORETICAL HIGH ENERGY ASTROPHYSICS
R. Ramaty 301-344-8715

The objectives are: (1) to conduct fundamental theoretical research in high energy astrophysics with particular emphasis on studies related to gamma-ray, X-ray, and cosmic ray astronomies; (2) to publish in the scientific literature and to present at professional meetings the significant results of such research; (3) to collaborate with and support theoretical research of graduate students, research associates and occasionally senior faculty members on leave from academic institutions; and (4) to provide theoretical support in planning space experiments in high energy astrophysics and to create the theoretical framework for the interpretation of the results from such experiments.

W80-70704 **389-46-04**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY ASTRONOMY DATA ANALYSIS
J. T. Swank 301-344-6188

Information about X and gamma-ray sources has grown steadily over the past few years with the discovery of new temporal and spectral phenomena in known sources, the resolution of new sources, and the identification of many with optical, infrared or radio objects. The data bases of many experiments contain further as yet unexamined information about these sources. The data from Ariel 5, OSO-8, HEAO-1 and HEAO-2 will span over 5 years and offer complementary information on the X-ray sky, including time variability of sources on time scales of milliseconds to years and spectra from .2 keV to 10 MeV. Systematic study is proposed, using data from the all sky monitor on Ariel 5, the OSO-8 GSFC Cosmic X-Ray spectroscopy and the HEAO A2 experiments, and the solid state spectrometer on the Einstein Observatory, of an enlarged source list, of spectral temporal correlations best studied with multiple observations and of the models recommended by results to date. These experiments also provide information on the non X-ray background which would be of use to future missions. Constraints on the positions of gamma-ray burst sources and spectral and temporal information would be sought in records available from experiments on IMP, HELIOS, and ISEE, as well as the contemporary X and gamma-ray experiments.

Astrophysics Explorer Studies

W80-70705 **685-20-06**
Goddard Space Flight Center, Greenbelt, Md.
EXTREME ULTRAVIOLET EXPLORER
Samuel Willis 301-344-8566

The objective of this RTOP is to provide a detailed study of the 4 telescopes with detectors and star camera in the trapezoidal EUVE configuration. The study includes the writing of detailed execution phase specifications. The study, to be funded through UCB must be done in sufficient detail to assure that the follow-on experiment hardware to be procured within the allocated cost.

W80-70706 **685-20-08**
Goddard Space Flight Center, Greenbelt, Md.
COSMIC BACKGROUND EXPLORER (COBE)
G. W. Longanecker 301-344-7751

The objective of the Cosmic Background Explorer (COBE) is to further the knowledge of science in the area of astrophysics; more specifically observation cosmology. COBE will make a definitive exploration and study of the diffuse radiation of the universe between the wavelengths of 8 microns and 13 mm. This band includes the 3K cosmic background radiation, thought to be the residual radiation from the Hot Big Bang which started the present expansion of the universe. It also includes the infrared region from 8 microns to 300 microns where the diffuse radiation of the universe has yet to be detected. This infrared band may include a large portion, if not the dominant part, of the energy content of the universe, including the radiation from primeval galaxies. A 1 year long mission is envisioned during which time the entire celestial sphere can be observed at least twice.

W80-70707 **685-20-15**
Goddard Space Flight Center, Greenbelt, Md.
EXPLORER PROGRAM DEVELOPMENT STUDY
Marius B. Weinreb 301-344-6849

The objectives are to perform studies and necessary research in support of continuing advanced definition of Explorer class missions. This effort helps to shape the future form of the Explorer Program in the area of Astrophysics. Strategies for new ways of carrying out missions are considered. Preliminary studies are carried out of new mission concepts. Systems are developed that meet the requirements of the scientific community as represented by strawman payloads and that fall within the cost constraints of the Explorer Program. The next mission which will be studied is an X-Ray Timing Explorer.

Sounding Rockets--Solar Terrestrial Experiments

W80-70708 **828-11-36**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS: MAGNETOSPHERIC PHYSICS EXPERIMENTS
James P. Heppner 301-344-8797

The objective is to perform measurements and experiments that lead to an understanding of the interactive processes that occur between neutral gases, plasmas, energetic particles, and electric fields in the atmosphere, ionosphere, and near the earth's magnetosphere. Emphasis is placed on measurements and experiments that utilize the unique characteristics of sounding rocket trajectories and/or the low cost, quick reaction sounding rocket approach which permits program flexibility. This approach has logically been extended to include: (1) piggyback experiments on the orbiting upper stage of two stage Delta vehicles; (2) experiments involving sounding rocket flights in association with simultaneous satellite measurements in selected geometrical coincidence between trajectories; and (3) flight testing of new instrumentation and measurement techniques.

W80-70709 **828-11-38**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS EXPERIMENT
R. O. Chapman 301-344-5101

The sounding rocket program provides unique capabilities to conduct a broad range of scientific invesgiations. The program is particularly important for the development and demonstration of the merit of new instruments for shuttle flights and of prototype instruments for satellites. Furthermore, the short lead time and program flexibility make it possible to follow up new discoveries and to study particular phenomena on the sun and in the earth's atmosphere. Extreme ultraviolet spectra of the sun are a valuable tool for determining the true physical conditions in the solar corona. Of particular interest are the determination of the flow of matter and energy from one region to another in the corona. For this purpose we need to know the coronal density, temperature, gas velocity, and radiation field. The work under this task is directed toward the development and flight on rockets of instruments for determining these four physical parameters in the corona. A better determination of the characteristics of the solar corona is necessary in order to discover the paradoxical reasons why a coronal gas temperature of more than one million degrees can be maintained by energy from a region whose temperature is only five thousand degrees. These measurements are also important for determining the origin of the solar wind, which may arise from regions of open magnetic field.

W80-70710 **828-11-38**
National Aeronautics and Space Administration, Washington, D.C.
SOLAR PHYSICS SOUNDING ROCKETS
J. David Bohlin 202-755-8490

The major objectives of the solar physics sounding rocket program are: (1) to conduct exploratory studies of the hot outer layers of the sun (chromosphere, transition region and corona) by lifting scientific payloads above the absorbing effects of the terrestrial atmosphere for periods of the order of 5 mins, pointing those payloads to selected features on the solar disc with a stability and accuracy of the order arc seconds and providing a capability for rapid data acquisition (film and telemetry); (2) to provide a short turn-around capability for testing new instrument concepts for theories; (3) to provide a mechanism whereby low-cost solar space research may be achieved, frequently leading to experiments on dedicated orbiting solar satellites; and (4) to provide a means of reacting to special situations (e.g. solar minimum or eclipses).

Sounding Rockets--Astrophysics

W80-70711 **879-11-41**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS EXPERIMENTS (ASTRONOMY)
T. P. Stecher 301-344-8718

The astronomical sounding rocket program provides a unique capability to conduct a broad range of scientific investigations. The program flexibility and short lead time make it possible to observe unusual physical phenomena for which satellite instrumentation is not available. The program flexibility makes it possible to expeditiously follow-up discoveries as well as to provide tests and calibrations of satellite instrumentation. This unique capability is exploited by obtaining one of a kind observations of those types of astronomical phenomena that do not need large amounts of repetitive data to delinate their physical processes. Many new types of observations are now possible because of recent technical advances in both attitude control and new detectors. These interstellar medium, stars, nebulae, and peculiar galaxies. The present objectives are to develop payloads to obtain ultraviolet images of the weak sources now accessible as a result of improved pointing devices. Old payloads are improved and used again and new payloads are developed to take advantage of modern sensors and image intensifiers. The properties of galaxies and peculiar galaxies will be stidied by means of their ultraviolet images. Procedures for absolute photometry of the stars and galaxies are investigated. All instrument development are done in such a manner that the instruments can be used on Spacelab.

W80-70712 **879-11-46**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS (HIGH ENERGY ASTROPHYSICS)
E. A. Boldt 301-344-5853

High energy astrophysics (especially X-ray astronomy) is a rapidly evolving field of research, both scientifically and technically. The exploitation of the capabilities of short lead time, planning flexibility, accurate pointing and extremely high telemetry rates (most important) afforded by rocket-borne experiments are major factors in the success obtained to date. A vigorous elaboration of this activity is now necessary for continuing to make timely and important contributions that complement the satellite missions and for the effective planning of advanced future missions. This involves experiments with systems incorporating newly developed spectrometers, X-ray concentrators, and imaging devices.

W80-70713 **879-11-46**
National Aeronautics and Space Administration, Washington, D.C.
HIGH ENERGY ASTROPHYSICS SOUNDING ROCKET RESEARCH
Albert G. Opp 202-755-8493
(188-46-56)

Sounding rockets provide the unique capability to study a broad range of astrophysical phenomena at low cost, and on a relatively short time scale. This enables an investigation to follow up a new discovery in an expeditious manner. In addition to their value as an independent research tool, sounding rockets also provide an inexpensive flight test of future spacecraft instrumentation. X-ray astronomers can use recoverable payloads for astronomical observation, and at the same time flight test the payload concept or use the rocket to calibrate a flight instrument.

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

Supporting Research and Technology

W80-70714 **310-10-23**
Goddard Space Flight Center, Greenbelt, Md.
SOFTWARE AND DISTRIBUTED COMPUTING TECHNOLOGY FOR FLIGHT DYNAMICS PROBLEMS
F. E. McGarry 301-344-5048
(310-10-26; 310-40-26; 310-10-25)

The primary objective of this RTOP is to develop methodologies for system development for flight dynamics computations. These methodologies are intended to significantly reduce the costs of such computations, and simultaneously improve the reliability of the computational systems. The costs associated with flight dynamics computations encompass a wide range of expenditures from requirements analysis to software and/or hardware system installation and maintenance for orbit attitude determination and control, and mission analysis computations. Under this research project, all aspects of system development will be investigated, including: techniques and tools to analyze requirements and system designs; methodologies and practices of software engineering; the feasibility of distributed computing concept using minicomputers and microprocessors for software development; the validity of programmer workbench concept and optimization of software/hardware configuration. The approach will be to establish a System Technology Laboratory in which the stated areas of systems development can be investigated under suitable conditions. This laboratory will support the research effort in the areas of data management and data analysis; high-level language compiler evaluation; software development tools; applicability of minis and micros for flight dynamics computations and multiprocessor simulation. From this research, a set of methodologies will be generated to direct system developers toward the reduction of overall system costs in the flight dynamics areas.

W80-70715 **310-10-25**
Goddard Space Flight Center, Greenbelt, Md.
INTELLIGENT TERMINAL SYSTEMS FOR FLIGHT DYNAMICS AND ORBIT OPERATIONS IN THE 1980'S
Thomas J. Grenchik 301-344-6373

The goal of this RTOP is to determine the capabilities of intelligent terminals and their effective application to the flight dynamics and orbit operations functions. The first year of the effort is being directed towards studying the present day capabilities in terminal technology, and examining ability to meet the needs of the analysis, operations, and software development functions. The second year of the effort will be to select and install an intelligent terminal system for hands-on testing of its capabilities. The final year of the effort will be to simulate selected functional operations to test and evaluate the intelligent terminal concept. Successful completion of this RTOP will enable orbit/attitude computing capability at the analyst/operator station

to significantly increase analyst/operator output and reduce mainframe computer loading.

W80-70716 **310-10-26**
Goddard Space Flight Center, Greenbelt, Md.
ATTITUDE-ORBIT ANALYSIS
W. H. Wooden, II 301-344-5666
(310-20-27; 310-10-23)

The objectives of this RTOP are to increase the efficiency and to decrease the resources needed to meet the requirements for spacecraft missions by: (1) the application of new data types and their onboard processing to attitude/orbit estimation in order to minimize the use of tracking and telemetry data for attitude and orbit determination and control, (2) the provision of generalized and flexible computer systems utilizing onboard and small ground computers to increase the speed of information flow to the user and to reduce the demand upon the central computer facility, and (3) the utilization of standardized sensor combinations, telemetry interfaces and computational algorithms suitable to meet the demands of changing computer environments to effect a reduction in the attitude and orbit determination software development cost. The approach involves the development of computational software to permit the analysis and evaluation of the coupled attitude-orbit landmark registration process. Such studies were started with simple attitude models. Extension to the use of wheel speed data and later to the use of gyro and star camera data was done. The generation of efficient reliable algorithms suitable for minicomputer and onboard implementation of autonomous attitude and orbit determination and control will be continued. Simulations of onboard processors will enable the evaluation of developed algorithms to be done.

W80-70717 **310-10-42**
Goddard Space Flight Center, Greenbelt, Md.
PRECISION TIME AND FREQUENCY SOURCES
Victor S. Reinhardt 301-344-8031
(644-03-15)

Improved frequency and time standards are to be developed with a frequency stability of 10 to the -15th power, to aid in the transfer of existing hydrogen maser technology to provide a contractor source of operational hydrogen masers. Improved frequency and time distribution systems for meeting critical NASA applications such as optical and microwave range and range rate tracking, and very long baseline interferometry are also to be developed. The objectives are achieved through the following task time tables: (1) operational hydrogen maser standards for NR Test and Evaluation (1/80), for Improved NR Masers Constructed (6/80), for Preliminary Low Cost Maser Design (9/80); (2) calibration standards for external bulb maser contructed (3/80), for calibration standards accuracy evaluation; and (3) time and frequency distribution and measurement systems for automated data acquisition system (1/80), for remote system (1/81).

W80-70718 **310-10-60**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADIO METRIC ANALYSIS, DEMONSTRATION AND INSTRUMENTATION DEVELOPMENT
M. P. Ananda 213-354-2804
(310-10-61)

The primary objective is to develop the advanced radio metric systems employed by the DSN for spacecraft navigation and radio science. The requirements which will be placed upon the navigation system by proposed future deep space missions are expected to be stringent. Thus, one of the major goals is to identify and investigate new navigation techniques and develop future systems. It is also of interest to enhance the radio metric system capabilities for supporting radio science investigations. The technical approach utilized includes: (1) investigation of accuracy requirements for Deep Space navigation and radio science applications; (2) exploration of advanced radio metric system concepts; (3) analytical evaluation of advanced techniques; (4) planning and design of the experiments to demonstrate new capabilities; (5) development of supporting and peripheral systems; (6) development of instrumentation to support the experiments; (7) demonstration of new technology via data acquisition, calibration and processing; and (8) development of end-to-end radio metric systems. Current navigation strategies rely upon two-way Doppler when tracking spacecraft at high (less than 10 degrees) geocentric declination and upon two-way ranging for low declination spacecraft. The system is capable of determining the angular position of the spacecraft to approximately 1.0-0.25 micro rad, depending on the geocentric declination. The major navigational thrust involves developing and demonstrating the Very Long Baseline Interferometry (VLBI) concepts as they apply to spacecraft navigation. With present, relatively narrowband spacecraft signals, the scheme having the highest potential accuracy is differential Delta VLBI, navigating the spacecraft relative to a very nearby quasar.

W80-70719 **310-10-61**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VLBI DEVELOPMENT AND ANALYSIS
J. L. Fanselow 213-354-6323
(310-10-60; 310-20-65; 310-30-68)

The objective is to obtain an understanding of the capabilities, and limitations of VLBI and, where practical, to reduce the effects of error sources in the application of this technique. This work is required for the DSN because it develops the technology which supports the new generations of VLBI based tracking systems now being considered for implementations. The specifics of the approach to accomplish the improved VLBI performance are on several fronts. Data reduction software is being developed, systems analysis and engineering performed, and demonstration VLBI data are being analyzed. Water vapor in the atmosphere has been shown to be the primary remaining significant error source. Hence, a water vapor radiometer at DSS 13 to measure the line-of-sight water vapor is employed. Temporal variations in the instrumental delays are also known to be significant error sources in VLBI. Measurement and modeling of the antenna mechanical variations, measurement and modeling of the delay in the antenna structure, and calibration of the RF electrical delay in the receiving system are work units designed to understand and reduce these instrumental effects. Finally, an understanding of the effects of the natural radio sources themselves is required. The spatial distribution of candidate radio sources is being obtained experimentally and techniques to estimate the potential impact of time variable source structure are being developed and demonstrated. Part of the resources are also devoted to the interim monitoring of the overseas H masers.

W80-70720 **310-10-62**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FREQUENCY AND TIMING RESEARCH
R. L. Sydnor 213-354-2763
(310-10-60; 310-30-68)

In the mid-1960's, the rubidium oscillator was implemented to replace the crystal oscillator standard and an improvement of nearly two orders of magnitude in frequency stability was realized. This was one of the first enabling technologies for precision planetary navigation. Today outer planet missions require a frequency standard five orders of magnitude more stable than the crystal baseline system. Currently, second generation Hydrogen-masers are being implemented to meet this requirement. In the future, navigation and experiments in gravitational physics will demand an additional stability improvement of three orders of magnitude. The goal is to conduct research and engineering and to carry out technology demonstrations of frequency and timing systems which meet the future requirements for navigation and spacecraft radio science. To meet the goal, primary objectives are established. The first objective is to evaluate the next generation hydrogen maser design. The approach will be to conduct extensive tests and do design and performance analysis on a Smithsonian Astrophysical Observatory VLG-11 maser and a GSFC NR maser in order to recommend a direction for future development. The second objective is to develop a state-of-the-art monitor system; unattended operations and remote control will be emphasized. Stable distribution of the frequency and time information is as essential as the stability of the oscillator; the third objective is to provide the technology for distribution within a station, within a complex, and throughout the network.

Microwave, fiber optics and bent pipe satellite systems will be investigated. All proposed new navigational techniques are critically dependent upon the performance of the frequency standards. Presently available high performance frequency standards have exhibited certain performance and reliability problems. The fourth objective is to solve these problems to increase the assurance of DSN performance.

W80-70721 **310-10-63**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NAVIGATION NETWORK DEVELOPMENT AND ANALYSIS
J. Lesh 213-354-2766
(310-10-60; 310-10-61; 310-10-62)

The objectives are to identify and validate the navigational requirements of the DSN in the 1980-1995 time period and to develop the most appropriate conceptual systems designs for satisfying those requirements. To accomplish these objectives a two part study has been initiated. The first part, the bulk of which is scheduled for completion during the last half of FY-79, will be devoted to identification and validation of the navigational requirements. Also, during this part of the study, the basic and limiting characteristics of the technologies of potential benefit in the satisfaction of those requirements will be evaluated. The second part of the study will be conducted in FY-80 and will be responsible for formulating, analyzing, and evaluating candidate systems designs which can meet those requirements. After completion of the study, follow on analysis and technical support during the initial phases of the Navigation Network construction will be provided.

W80-70722 **310-10-64**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
X-BAND UPLINK DEVELOPMENT
R. M. Dickinson 213-354-4273
(310-20-66; 310-30-68; 310-30-69)

The development of an automated, phase stable 20 KW uplink exciter and transmitter at X-band (7145-7235 MHz) for use in future DSN activities is continued. Continuing support for maintaining a super power transmitter capability at both X- and S-band for use in planetary radar astronomy and for developing technology applicable to future high power transmitters in the DSN is also provided. The approach is to contract for the upgrading of a DSN surplus heat exchanger and power supply to interface with a JPL developed transmitter automation software program. The development of the wideband exciter phase modulator will also be contracted. JPL in-house effort will specify, procure and integrate these and other components for a FY-81 transmitter prototype demonstration at DSS 13.

W80-70723 **310-20-27**
Goddard Space Flight Center, Greenbelt, Md.
NETWORK TIMING AND SYNCHRONIZATION TECHNOLOGY
A. R. Chi 301-344-7502

The objectives of this research are to study and develop techniques for time synchronization, to coordinate time determination methods and dissemination formats to meet NASA needs, and to conduct theoretical investigations and experimental tests for NASA applications. The approach is to develop a satellite time transfer system with which to test a new operational concept of transferring precise time and time interval from the ground via a satellite to the users in another satellite or on the ground. The time transfer technique selected from this program is that developed earlier under a joint program between NASA and the Federal Aviation Administration. It is the two way satellite time transfer technique with which the propagation path delay can be measured and removed so that the signal received at the user's station is on-time relative to the ground station reference clock. If the propagation path delay is known, one-way time transfer technique can be used, limited in accuracy only by the uncertainty of the path delay. Study results show that the system concept and preliminary hardware design are compatible with the Tracking and Data Relay Satellite System (TDRSS) design and applicable to the new data management concept and the planned goal to achieve spacecraft autonomy.

W80-70724 **310-20-31**
Goddard Space Flight Center, Greenbelt, Md.
ANTENNA SYSTEMS DEVELOPMENT
Thomas Keating 301-344-8873

The first objective is to develop a set of analytical programs to permit cost effective analysis of a broad range of antenna types based on: frequency, size, type of reflector (parabola, cassegrain, shaped, solid, mesh, etc.) and use (space, ground, telemetry, autotrack, etc.). The approach is to minimize computer costs while assuring applicable accuracy. The second objective is to develop a microprocessor that will be a building block in the development of 'unattended' antenna systems for NASA's unique requirements. The microprocessor controller will provide the pointing necessary for antenna and laser systems. This controller will replace unique analog equipment and custom designed logic circuitry which is presently used in the servo tracking system. There is sufficient similarity between laser and antenna control systems that will permit the development of one controller for both applications.

W80-70725 **310-20-33**
Goddard Space Flight Center, Greenbelt, Md.
NETWORK SYSTEMS TECHNOLOGY DEVELOPMENT
J. J. Schwartz 301-344-7313

The objective of this RTOP is to investigate the applicability of new technology in the network systems. Selected technology will be investigated by means of feasibility studies, prototype development and demonstration, and by cost and reliability impact studies. A major goal will be to carry out preliminary studies of a second generation Tracking and Data Relay Satellite System (TDRSS). A second goal is to investigate the effect of nongaussian channel characteristics on TDRSS link performance and develop coding and signal designs which can optimize link performance. Associated with this goal is the objective of validating the analytical predictions by means of limited hardware simulations. Third, an investigation will be made of wideband data matrix switches and transmission lines using fiber and integrated optics technology. The feasibility of introducing this technology into the next generation switching systems in the Space Tracking and Data Network (STDN) will be investigated, and a prototype switch developed.

W80-70726 **310-20-46**
Goddard Space Flight Center, Greenbelt, Md.
RF TECHNOLOGY FOR TDRSS USER SPACECRAFT
R. P. Hockensmith 301-344-6756
(506-20-46)

The objective of the work under this RTOP is to achieve technological advances in RF and antenna systems in order to satisfy future requirements of spacecraft and space transportation system (STS) payloads that require near global coverage by the Tracking and Data Relay Satellite System (TDRSS) to support the space mission user. The approaches for accomplishing the objective are to (1) identify the basic RF operational requirements of the mission; (2) investigate RF active and passive components and antenna systems that are feasible, but may be a technical risk to missions, to attain the required mission RF performance; (3) develop system designs incorporating the optimum subsystems to permit the spacecraft projects to obtain proven, reliable hardware with a high confidence level in the performance capability and with a reasonable procurement cycle; and (4) exploit testing techniques that properly characterize these critical RF systems.

W80-70727 **310-20-47**
Goddard Space Flight Center, Greenbelt, Md.
GSTDN SYSTEM OPTIMIZATION
H. Theiss 301-344-7526

Costs for operating the GSTDN are escalating at an ever increasing rate. The major cost factor is in site manning for operating and maintenance. Existing equipment at the sites require a high degree of operator interaction for all phases of mission support. Further, there is a great deal of vulnerability to operator error with the present manual operation. The present decentralized operating method calls for an operating crew of approximately twenty technicians positioned at front panel controls of the various

equipment groups. Their actions are coordinated by voice intercom with the link control (supervisory) positions. Although each operator is normally quite proficient in controlling his equipment group, the processes of configuration, set up and coordinated operation are inefficient, time consuming and prone to operator error. Further, long duration passes, which will be prevalent in the post TDRSS period, require that an operator observe front panel monitors for hours at a time.

W80-70728 **310-20-65**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ANTENNA SYSTEMS DEVELOPMENT
R. Levy 213-354-3872

The technology for optimizing communications capabilities of the DSN antenna system and mechanical components for application within the flight-ground communications link of planned NASA missions to the outer planets are developed. Measures of communications capabilities are antenna figure of merit, usable operational frequencies, data transmission rates, and environmental limits upon operational availability. One goal of the technology is to optimize the ratios of communications capability to life cycle costs. Another goal is to identify the options and provide data for the purpose of planning future missions for the acquisition of telemetry data. Advances in ground antenna performance and capabilities are developed by microwave, structural, mechanical, and control system technologies. These are supplemented by optimization techniques to reduce life cycle costs. Microwave technology is applied to provide dual frequency X and S-band feeds, to develop effective alternatives to the present reflex feed sytems, and to investigate and design new offset antennas that have clear apertures and shaped, quasi-paraboloidal surfaces. An underlying guideline to performance in the X-band frequency range. The offset antenna configurations, which have a potential of a 3 db gain improvement with respect to symmetrical antennas of equivalent aperture, require new structural and mechanical concepts to maintain these surfaces and to point the RF beam accurately. Studies of these and other antenna-related structures are facilitated by software to automate the application of design and analysis procedures. Control system and mechanical technologies are applied to enhance antenna pointing accuracy, to reduce maintenance and mechanical component costs, and to extend antenna availability by improving the reliability of components within the pointing system.

W80-70729 **310-20-66**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RADIO SYSTEMS DEVELOPMENT
W. H. Higa 213-354-4240
(310-10-61; 310-20-65; 310-30-69)

The objective is to improve the spacecraft-to-ground radio system elements of the communications link in order to meet the future navigation and high data rate telecommunications requirements of the planetary exploration program. Future missions to the outer planets will require sensitive and stable, higher frequency receivers and wideband radio communications for high rate video, telemetry, navigation, and radio science data. They will also require calibration and models of the propagation medium and of the DSN ground radio parameters for efficient link design. The natural microwave environment due to the atmosphere places a limit on the sensitivity obtainable by Earth-based microwave receiver systems; therefore the environment needs to be monitored so that accurate statistical models of meteorological effects on communications are available for mission design purposes. Parametric upconverters will be developed and demonstrated at S- and X-band to provide maser-like noise temperatures with wide instantaneous bandwidth (300-500 MHz) and large tuning ranges. An additional objective is to develop a compact system with multiple upconverters and two masers in one cryogenic refrigerator. This technique may permit the use of one standard maser design for many frequency bands which will result in reduced costs. A long-life, 2 watt, 4.5 Kelvin Closed Cycle Refrigerator (CCR) development is included in this effort. This system will provide multi-frequency, standard, low-noise amplifier packages for the DSN. A new effort undertaken is the study of efficient, long-life cryocooler techniques for the DSN masers. A key area requiring study and development is the highly efficient helium compression techniques capable of long unattended operation.

W80-70730 **310-20-67**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MULTIMEGABIT TELEMETRY DEVELOPMENT
R. A. Winkelstein 213-354-3843
(310-10-60; 310-20-66; 310-30-69; 310-40-73)

The objective is to develop the technology necessary for expanding the telemetry data reception and processing capability of the DSN to the 30 Msps region while maintaining or enhancing other DSN system requirements such as low rate telemetry and precision spacecraft radio metric measurements. To accomplish this objective a developmental program was initiated which will lead to a feasibility model of a telemetry demodulator-detector assembly capable of processing telemetry signals in the region from 100 Ksps to 30 Msps. The necessary test equipment and other support equipment required for this development will also be developed or purchased. Simultaneous with this development a commercial off-the-shelf telemetry modulator-demodulator covering approximately this data rate range will be purchased and evaluated. These two activities will lead to a thorough understanding of the needs of the DSN concerning multimegabit telemetry and the ability of the commercial sector to satisfy these needs. This knowledge will enable an intelligent make or buy decision with regards to further development. If a buy decision is reached, a contract will be let for the development of a prototype demodulator-detector system which can operate within the context of the DSN. Otherwise, the inhouse development will continue through a prototype model. Additionally, a systems design will be initiated for the development of a complete multimegabit telemetry reception system. Also, the technology created by this high rate development will be applied to the low rate telemetry problem to guide the development of a universal telemetry system which will replace the existing aging equipment. The technology developed has direct application to the VOIR mission and to the Orbiting Deep Space Relay Station and will remove the data rate limitations on all future flight projects.

W80-70731 **310-30-68**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STATION AND NETWORK MONITOR AND CONTROL TECHNOLOGY DEVELOPMENT
C. Foster 213-354-5070

Techniques are being developed for unattended tracking station operation. The objective is to obtain the data needed to determine how unattended station operations can increase network productivity and decrease network life-cycle costs. The approach is the development of DSS 13 as a remote-controlled unattended station. Information obtained from the development itself and from subsequent use of the station will form a data base to used in RTOP 310-40-73 to predict life-cycle costs of automation and to study the feasibility of implementing an automated network. A number of demonstrations will be conducted to study the applicability of unattended operations to the various types of activities supported by the DSN. In particular, during the DSS 12 down time for S-X conversion, DDS 13 was used in an unattended mode to supplement flight project tracking and to accumulate data about the reliability and capability of unattended spacecraft tracking. Because substantial progress has already been made in the automation of command and telemetry processing, the emphasis here is on the RF and electromechanical subsystems.

W80-70732 **310-30-69**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RFI SYSTEMS TECHNOLOGY
B. K. Levitt 213-354-3848

The objective is to develop the technology to alleviate the RFI problem confronting the DSN. In particular, an extremely sensitive, wideband, digital RF surveillance system is being developed to monitor the RF environment at the Goldstone DSN complex. Beginning in FY-80, cryogenic filters will be developed to eliminate adjacent band interference. From FY-81 to FY-83, techniques for desensitizing the DSN to RFI will be studied and demonstrated in the field. The RF surveillance station will

initially contain a 15 MHz, 65K line spectrum analyzer based on digital FFT techniques. The entire system will be composed of an 18 dbi, 25 degree beamwidth circular horn antenna, a 150K, 300 MHz S-band receiver, the spectrum analyzer, and a Modcomp digital computer for controlling system operations and reducing observed data to a manageable and user-oriented format. The RF monitoring system will be housed in a trailer, and will undergo six months of testing at Goldstone during the first half of FY-80 to demonstrate its operational capability and allow its data algorithms to be adapted to the characteristics of the observed RF environment at the DSN complex (not adequately known at this time). One goal of this test phase is the establishment of a data base of observed RFI signatures (spectral characteristics, receive level, duration, direction, frequency of concurrence, and if possible, source identity). Although initial observations will be made at the Goldstone Operational Support Radar (GOSR) hillsite, the portable nature of the RFI trailer will allow measurements to be taken beside individual stations or even at overseas DSN complexes if the need arises. In the next development phase during FY-80 and FY-81, the RFI surveillance system will be upgraded to provide an 80 MHz, 260K line capability at S- and X-band.

W80-70733 **310-30-70**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NETWORK SIGNAL PROCESSING CONCEPTS
G. S. Downs 213-354-2765

The objectives are broad in scope, and yet are confined to providing a focus for the Advanced Systems work in signal processing. Data acquisition concepts and hardware are tested under field operating conditions. Design techniques of data acquisition hardware are investigated and implemented. New fabrication techniques of signal acquisition and processing subsystems are studied and implemented. Processing components are investigated and incorporated into hardware. The theoretical (communication and information) aspects of signal transfer problems are studied. The work for FY-80 includes the activation of two new work units. A study of single purpose arithmetic processors will begin. A multi-processor architecture (employing many of these devices) will be designed for the purpose of solving a wide range of DSN signal processing problems. Implementation is in FY-81. Participation in the Caltech-Industry large scale integration (LSI) project will intensify. The design of particular signal processing units will begin mid FY-80. The LSI system documentation and DSN interfacing (highspeed, versatile data acquisition demonstration) will be obtained. The subsystem components upgraded in-house (digital demodulators, coders, computer interface bus) will be completed near mid FY-80. Installation of the new computer for overall system control will begin in the 3rd quarter (purchase and purchase management of the computer will be handled under a yet unspecified work unit). The system demonstration will continue through radar probes of six solar system bodies. The long term objective is an in-place transfer of the system to DSN operations. On the theoretical side, a study of coding schemes applicable to optical channels will take place during FY-80, and a study of error correcting codes will begin FY-80. A study for implementation of decoding algorithms for block codes, begun in FY-79, will be completed in the first quarter. Work on improving decoding algorithms will continue until FY-80.

W80-70734 **310-40-26**
Goddard Space Flight Center, Greenbelt, Md.
EVOLUTION OF OPERATIONS SUPPORT COMPUTING SYSTEMS
R. L. Larsen 301-344-5197

RTOP 310-40-26 supports the evolution of ground orbit determination and computation activities into the 1980's. This RTOP is a systems study of the orbit determination and computation function as it relates to the end-to-end flow of data from its capture onboard a spacecraft to its delivery to an investigator. This study is in concert with the NASA End-to-End Data Systems (NEEDS) study. It consists of five study areas: sensitivity analysis, system organization, data flow analysis, advanced computational concepts, and advanced operational concepts.

W80-70735 **310-40-36**
Goddard Space Flight Center, Greenbelt, Md.
AUTOMATIC DATA HANDLING
John C. Rodgers 301-344-8189
(310-10-25; 310-10-23)

Two tasks are included in this RTOP. The first is the development of an advanced computer terminal to provide more efficient interaction between host computers and terminals by remoting interactive functions of the host computer to the terminal. The terminal will also perform as a stand-alone computer for mid-size programs, thereby off-loading responsibility of the large host for job classes which the terminal can better perform. The second task is to develop communication control techniques to effectively utilize satellite communications bandwidth. Optimum techniques by which multiple users on multiple computers at multiple geographic locations can share a satellite communications bandwidth will be studied, and a prototype system will be developed.

W80-70736 **310-40-37**
Goddard Space Flight Center, Greenbelt, Md.
NATURAL HUMAN-TO-MACHINE INTERFACE
R. desJardins 301-344-5646

The objective of this RTOP is to develop one or two prototype natural human-to-machine interfaces for space payload and ground systems control. Natural in this context means English-language-like. The intention is to apply recent advances in low cost computer systems hardware and artificial intelligence software techniques to restricted operational language interpretation and display problems. The approach to be taken is, first, to identify and describe precisely several tractable problem areas, and second, to develop a human-to-machine interface oriented, knowledge engineering laboratory and use it to conduct subsystem experimental research. These two steps would be performed under university contract. The third step, if warranted, would be to develop one or two full scale prototypes to run in parallel and be evaluated against conventional operational systems. This last step would be performed under industry contract. The approach proposed is fundamental, i.e., it focuses on applied research concerning the underlying knowledge representations and processing--the knowledge engineering aspect of the problems--rather than on the hardware engineering of the interfaces. The intent is to go beyond pure systems engineering to seek basic understandings regarding the deeper information processing complexities of the human interface.

W80-70737 **310-40-39**
Goddard Space Flight Center, Greenbelt, Md.
IMAGE PROCESSING FACILITY PERFORMANCE EVALUATION METHODS
B. Peavey 301-344-8995

This RTOP supports the development and implementation of performance evaluation methods and 'tools' for the digital image processing systems of the Image Processing Facility (IPF). Performance evaluation is made of image processing characteristics such as radiometric corrections, geodetic and temporal registration, and total system transfer function (which affects resolution and radiometry). Studies are conducted to determine implementation feasibility of already developed methods (software) on existing systems such as Modcomp 4, Interdata/AP-120B processor, and Perkin-Elmer Microdensitometer. Image data and format simulation and dynamic image display are needed 'tools' to be developed. A study will be done to determine and define appropriate image data and format characteristics to be simulated on existing systems. In addition, the conceptual software design for a general purpose simulation capability will be developed and prepared for implementation. The dynamic image display (DID) method will be studied in terms of displaying images of various sizes (digital arrays) on a screen so as to permit a trained observer to discern and identify defects and anomalies associated with image processing in a 'production environment,' without having to resort to intermediate steps such as film recording and processing.

W80-70738 **310-40-44**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE COMPUTER CONTROL
William E. Holmes 301-344-5427

The objective of this RTOP is to provide a microprocessor based system between a host computer and any touchtone telephone. This microprocessor based system is directly connected to the host computer and utilizes voice input/output and touchtone input/output when connecting to the telephone system. This computer-to telephone system is implemented in three phases using the latest state-of-the-art microprocessor. Phase one is system design. Phase two consists of the implementation of the computer-to-telephone portion of the system without voice input/output capability. Phase three involves implementing voice input/output on the system. The commands and responses communicated over the telephone are a subset of the commands and responses usually associated with conventional terminal input/output. It is intended that this computer-to-telephone system be utilized to control computer task flow. That portion of the computer dialog usually associated with verbiage is implemented using voice input/output. Touchtone input is used when touchtone is more convenient than voice input. Touchtone output is used to dial a telephone number when user determined conditions are satisfied.

W80-70739 **310-40-72**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NETWORK CONTROL AND DATA PROCESSING DEVELOPMENT
R. C. Tausworthe 213-354-2773
(310-30-68; 310-30-69)

The objective is to develop the techniques necessary for the efficient and cost-effective application of computational resources to the jobs of the DSN. Information system engineering methods being devised will improve management control of systems development and facilitate the production of user-responsive functional requirements, through detailed software design and implementation tasks. The Advanced Systems segment of the DSN Programming Systems work utilizes pathfinder projects such as elements of the DSN programming system to develop and tune an Information Systems Engineering Methodology appropriate to DSN needs. This methodology in turn contributes to Standard Practices, standard tools and languages, etc., for DSN Implementation to improve the overall productivity of the DSN.

W80-70740 **310-40-73**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NETWORK PRODUCTIVITY RESEARCH
J. G. Smith 213-354-3828
(310-30-68)

The objective is to increase the effectiveness of DSN use of NASA Resources for tracking and data acquisition support of light projects and other end-users. The steadily rising cost of providing flight project support is rapidly consuming the resources available to meet needed new flight project support requirements. The remedy is either to secure more funding or to increase network productivity and cost-effectiveness: network productivity is the ratio of end-use station hours to operations and operations support work-years; network cost-effectiveness is defined as end-user station hours per dollar of DSN funding. The approach used is threefold. First, research at the DSN system level will assess the feasibility and cost-effectiveness of future options for improving the planetary telecommunications capability. Second, economic tools are being developed to permit quantitative assessment of network productivity and cost-effectiveness. Finally, detailed assessments will be made of specific concepts which offer promise of meeting particular DSN needs. This allows the full impact of new technology or alternate methods of providing DSN services to be evaluated prior to the expenditure of large amounts of implementation funds. Specifically, the project will: construct analytic models for the fundamental components of life-cycle costs, formulate models of the maintenance and operation of DSN subsystems, provide analyses of the cost-effectiveness and productivity of the unattended operations demonstration conducted under RTOP 310-30-68, compare ten-year life-cycle costs of providing 6 db increase of X-band telemetry capacity on the spacecraft or at the ground site, determine costs and performance of several spatially diverse DSN configurations, and examine the impact of the operating frequency band.

OFFICE OF SPACE TRANSPORTATION SYSTEMS

Advanced Programs

W80-70741 **906-50-01**
Marshall Space Flight Center, Huntsville, Ala.
A 25kW POWER MODULE SYSTEMS DESIGN (OB)
Luther Powell 205-872-5311

The objective of these studies is the preliminary design (Phase B) of the 25 kW PM Systems and development of planning and cost data to support a subsequent hardware design and fabrication contract.

W80-70742 **906-50-19**
Marshall Space Flight Center, Huntsville, Ala.
DESIGN AND FABRICATION OF P(3) PRODUCTION PROTOTYPE, ENGINEERING MODEL AND GSE
William G. Bodie 205-872-5318

The objectives are to design, develop, test and evaluate microprocessor controlled high voltage power processing equipment to provide programmable control, 5-year life, reduced power system weight and cost, and increased power system efficiency for the 25 kW power module.

W80-70743 **906-50-20**
Marshall Space Flight Center, Huntsville, Ala.
A 25 kW PM POWER SYSTEM BREADBOARD SUSTAINING ENGINEERING
J. Miller 205-872-2113

These funds will be used to (1) procure parts and hardware to incorporate modifications and improvements that will be identified as studies on the 25 kW PM progress and as the test results indicate; (2) update software as the mission profile is better defined and as test results are evaluated and incorporated; (3) procure parts and hardware to modify, replace, and/or repair test equipment, fixtures and hardware as required by wearout, changes, and/or new requirements; and (4) replace expendables such as recording paper, charts, etc., as used.

W80-70744 **906-50-25**
Marshall Space Flight Center, Huntsville, Ala.
ORBITAL LIFETIME PREDICTIONS
George Wittenstein 205-453-1093

The objectives are to improve the accuracy of and confidence in the solar activity indices used in atmospheric models; to review and select thermospheric density models of the earth's upper atmosphere to be used as the atmospheric input in spacecraft orbital decay and lifetime estimates, and to study and reduce systemmatic biases in use of the models; and to review current methods used to monitor real time solar activity and relate such observations to their occurrence within the evolutionary cycle and also to the indices commonly used for solar activity descriptions.

W80-70745 **906-50-26**
Marshall Space Flight Center, Huntsville, Ala.
A 25 kW PM/PAYLOADS INTERFACE CONCEPT AND AUTOMATIC UMBILICAL SYSTEM
W. Johnson 205-872-0362

The objectives are to (1) develop interface concepts between PM/free flying payloads (may be applicable to PM/orbiter), design umbilical system for PM, and (2) fabricate and test working model of selected umbilical system.

W80-70746 **906-50-27**
Marshall Space Flight Center, Huntsville, Ala.
EFFECTS OF SOLAR RADIATION ON GLASSES
R. L. Nichols 205-872-1222

The objectives are to assess durability of glasses subjected to solar radiation; determine optical degradation and mechanical degradation; conduct fracture mechanics analysis; determine the relationship of composition to loss of properties; and generate necessary design data.

W80-70747 **906-50-31**
Marshall Space Flight Center, Huntsville, Ala.
EFFECTS OF SPACE EXPOSURE ON COMPOSITE MATERIALS AND EFFECTS OF OUTGASSING PRODUCTS ON SOLAR ARRAYS
C. F. Smith 205-872-5085

The objectives are to (1) evaluate effects of long term exposure to the space environment on composite materials to determine property changes, outgassing rates and outgassing products; (2) quantitatively determine the degradation in solar array performance due to redeposition of outgas products on critical, optical surfaces; and (3) establish criteria for selection of composite materials to ensure minimum property degradation & zero contamination potential.

W80-70748 **906-51-11**
Lyndon B. Johnson Space Center, Houston, Tex.
PEP SOLAR ARRAY DEFINITION/REPAIR CONCEPTS
J. Cioni 713-525-6491

Through in-house activities reference PEP Solar Array Designs will be assessed analytically and through test to evaluate and verify a PEP peculiar maintenance philosophy.

W80-70749 **906-51-13**
Lyndon B. Johnson Space Center, Houston, Tex.
PEP (POWER EXTENSION PACKAGE) POWER CONDITIONING EVALUATION
W. C. Stagg 713-525-2586

The objective of this RTOP is to provide an analysis of PEP electrical power system operation and requirements through evaluation of power conditioning concepts, operation of a simulated PEP electrical power system with a simulated orbiter EPDC (electrical power distribution and control) system, and operation of a simulated PEP electrical power system with an actual orbiter fuel cell in order to verify the results of the simulated orbiter EPDC testing and to evaluate the effects of long term operation in the PEP mode on orbiter fuel cell performance. Expected results are the determination of the optimum power conditioning concept out of the four prime candidates to be evaluated, verification of proper operation of the proposed PEP electrical power system with the orbiter EPDC system, and determination of load sharing characteristics between the PEP and the orbiter fuel cells, including the effects of fuel cell purge cycle performance degradation on achieving the desired PEP operating point of 1 kW output per fuel cell.

W80-70750 **906-51-14**
Lyndon B. Johnson Space Center, Houston, Tex.
PEP/RMS DYNAMICS ANALYSIS
H. Kaupp 713-525-2094

The objective of this task is to perform advanced design studies to develop flight control techniques and software requirements as inputs to the overall PEP design activities. Included will be necessary orbiter flight control system and RMS software design modifications necessary to accommodate the PEP operational requirements.

W80-70751 **906-51-16**
Lyndon B. Johnson Space Center, Houston, Tex.
PEP ROTATING GIMBAL
J. Cioni 713-525-6491

The objective of the activity under this RTOP task is to perform testing to assess PEP/Orbiter interface using breadboard hardware derived from the FY-79 RTOP activity with orbiter EPDC breadboard and PEP breadboard hardware.

W80-70752 **906-51-18**
Lyndon B. Johnson Space Center, Houston, Tex.
PEP - SOLAR ARRAY SYSTEMS ANALYSIS SOFTWARE DEVELOPMENT
Walter Scott 713-525-3278

The task will develop the data base and modeling necessary to provide (1) an assessment of PEP performance, and (2) integrated PEP orbiter interface analyses. Data obtained from hardware testing and component specification will be utilized in the flight planning analysis.

W80-70753 **906-51-20**
Lyndon B. Johnson Space Center, Houston, Tex.
ENHANCED ORBITER CARBON DIOXIDE REMOVAL SYSTEM
F. Collier 713-525-4823

Existing prototype solid amine CO2 removal hardware will be evaluated at JSC in a systems-level test program to demonstrate applicability to extended duration STS missions as a replacement for lithium hydroxide.

W80-70754 **906-51-21**
Lyndon B. Johnson Space Center, Houston, Tex.
AUGMENTED ORBITER HEAT REJECTION STUDY
W. E. Ellis 713-525-4941

In order to relieve some of the vehicle attitude restrictions required by the orbiter space radiator system for baseline and extended capability STS missions, a study will be conducted to identify a modification kit to improve heat rejection capabilities.

W80-70755 **906-51-22**
Lyndon B. Johnson Space Center, Houston, Tex.
PEP SOLAR CELL DEVELOPMENT
J. Cioni 713-525-6491

The objective of the activities under this RTOP is to develop and qualify a wraparound contact solar cell for PEP use.

W80-70756 **906-53-13**
Marshall Space Flight Center, Huntsville, Ala.
SPACECRAFT CHARGING
C. R. Chappell 205-453-3036

The objective is to provide information, useful in the development of spacecraft design criteria, on the characteristics and behavior of the plasma of geosynchronous orbit and on its interaction with spacecrafts operating there.

W80-70757 **906-53-14**
Marshall Space Flight Center, Huntsville, Ala.
SOLAR FLARE ALERT SYSTEM DEFINITION
M. J. Hagyard 205-872-0118

The NOAA conctractual effort has the objective to define an optimum array of instruments for a solar flare alert system. Specific objectives are the specifications of system reliability and accuracy, and a quantification of anticipated prediction lead-time. Further objectives are to acquire vector magnetic field data on major cycle 21 solar flares with the MSFC RTSM and to perform correlative analyses of these events. Major solar flares can produce GeV- and MeV-energy charged particles which represent extreme hazards for geosynchronous missions such as the orbital transfer vehicle solar electric propulsion and geostationary platform.

W80-70758 **906-54-11**
Lyndon B. Johnson Space Center, Houston, Tex.
REGENERATIVE LIFE SUPPORT INTEGRATION AND TEST
C. D. Thompson 713-525-4823

This task will integrate preprototype subsystems into a JSC facility test set-up in order to evaluate and exercise the hardware fully.

W80-70759 **906-54-13**
Lyndon B. Johnson Space Center, Houston, Tex.
ATMOSPHERE REVITALIZATION SUBSYSTEM DEVELOPMENT
N. Lance 713-525-3343

This task will develop an improved CO2 removal subsystem for extended orbiter operations.

W80-70760 906-54-14
Lyndon B. Johnson Space Center, Houston, Tex.
WATER RECOVERY SUBSYSTEM DEVELOPMENT
B. Reveley 713-525-3343
The objectives of this RTOP are to provide for development of an improved vapor compression distillation (VCD) water recovery flight prototype through the phases of design, fabrication, and test. This prototype will employ the best design features and improvements of previous units and will be sized to meet the requirement of currently anticipated missions.

W80-70761 906-54-15
Lyndon B. Johnson Space Center, Houston, Tex.
REFURBISHMENT OF LIFE SUPPORT SUBSYSTEMS
F. H. Samonski 713-525-4823
This task will refurbish preprototype hardware for further evaluations in an integrated test in a 20 ft chamber.

W80-70762 906-55-01
Marshall Space Flight Center, Huntsville, Ala.
SPACE FABRICATION FLIGHT DEMONSTRATION DEFINITION
Hugh Dudley 205-872-2813
A preliminary design concept for a low cost, space fabricated and assembled structure that will support the design and construction in later years of larger space built platforms like satellite power system is the objective of this study. This relatively simple platform will demonstrate and verify the essential aspects of space construction such as: packaging and transportation, manufacturing of a standard beam in space, using an automated Beam Builder, assembly methods, ancillary tools and fixtures, joining devices, performance of the Shuttle as a construction base, and test of the completed structure.

W80-70763 906-55-11
Marshall Space Flight Center, Huntsville, Ala.
BEAM MACHINE TEST, EVALUATION AND DEMONSTRATION
C. N. Irvine 205-872-1520
This RTOP consists of a beam machine characterization; full determination of operational capability and evaluation of current design concept.

W80-70764 906-55-12
Marshall Space Flight Center, Huntsville, Ala.
BEAM MACHINE-COMPOSITE HEAD
H. M. Walker 205-872-0643
The objectives are to demonstrate composite beam cap fabrication by a continuous process; design composite beam cap fabrication element; and fabricate and demonstrate composite beam cap module, attached to the Grumman beam builder.

W80-70765 906-55-14
Marshall Space Flight Center, Huntsville, Ala.
STRUCTURES ASSEMBLY EVALUATION
Jack Stokes 205-872-4430
The objective is to purchase materials to support ongoing engineering evaluation of current large structures assembly operations.

W80-70766 906-55-15
Marshall Space Flight Center, Huntsville, Ala.
LSS/STABILIZATION AND CONTROL
M. T. Borelli 205-872-2868
The objective is to develop control and stabilization techniques for a multiunit modular space platform during and after assembly in orbit, and capable of adapting to wide ranging operational control requirements.

W80-70767 906-55-16
Marshall Space Flight Center, Huntsville, Ala.
EXPANDABLE UV-RIGIDIZED MATERIALS FOR SPACE STRUCTURES
W. J. Patterson 205-872-3536
The objectives are to develop/optimize UV-rigidizable resin systems as matrices for expandable space structural components; develop/evaluate stowage, deployment, and rigidization techniques for resin/reinforcment composites; and fabricate prototype articles utilizing an optimized system.

W80-70768 906-55-17
Marshall Space Flight Center, Huntsville, Ala.
LSS/MECHANICAL FASTENING/EVOLUTION INVESTIGATION
J. H. Ehl 205-872-1520
The objective is to develop mechanical methods of fastening components in space for fabrication and assembly of large space structures. Mechanical fastening concepts are proposed as an alternative to the currently baselined spot welding technique for the beam machine.

W80-70769 906-55-18
Marshall Space Flight Center, Huntsville, Ala.
STRUCTURAL ATTACHMENTS FOR LARGE SPACE STRUCTURES
E. E. Engler 205-872-3958
New concepts of structural attachments will be developed and evaluated for manned space assembly suitability in the neutral buoyancy facility.

W80-70770 906-55-19
Marshall Space Flight Center, Huntsville, Ala.
ALUMINUM BEAM BUILDER ANALYSIS
E. E. Engler 205-872-3958
The objective is to establish detail design and analysis of the required flight structure for the space fabrication demonstration for building a continuous beam.

W80-70771 906-55-20
Marshall Space Flight Center, Huntsville, Ala.
EVALUATION OF SPACE COMPATIBLE LUBRICANTS
F. Dolan 205-872-1504
The objectives are to evaluate commercially available and newly developed greases and dry-film lubricants for application to mechanical components and mechanisms in the space program; complete evaluation of 33 candidate greases in ball bearings; and select the four best materials at each test condition and evaluate these for five years under various environmental conditions.

W80-70772 906-55-22
Lyndon B. Johnson Space Center, Houston, Tex.
A COMPOSITE GEODETIC STRUCTURE FOR SPACE CONSTRUCTION
T. J. Dunn 713-525-2276
The objective is to develop the technology required to construct geodetic structural members in space using long coiled rod stock made of composite material. Cylindrical structural members will be constructed by overlaying rods to form a cylindrical surface composed of an equilateral triangular gridwork of continuous rods joined together at their cross-over points. End closeout structures and attachment fittings will be designed. The material will have a high specific rigidity, a near zero coefficient of axial thermal expansion and will be compatible with the required fabrication processes as well as the space environment. Techniques for joining the material in space will be developed. Automatic fabrication tooling will be designed and developed. Structural analysis routines will be developed. Test articles will be built and tested to quantify structural parameters. This effort will support the design and construction of very large structures in space such as communication platforms, earth applications satellites, and solar power stations.

W80-70773 **906-55-23**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE FABRICATION - COMPOSITE FORMING AND WELDING SUBSYSTEM DEVELOPMENT
L. Jenkins 713-525-3405

Beam builder development would be started in FY-80 based on preliminary designs produced under NAS9-15310, space construction automated fabrication experiment. Roll forming and welding technology as well as a prototype test truss will be evaluated in FY-79 with $125K of large space structure technology funds (OAST). Modular subsystem development would proceed on an incremental funding basis with the forming and welding subsystems to be developed first. The subsystems would be incorporated into an integrated ground test machine, fabricated in the FY-81-82 time period for testing in JSC facilities.

W80-70774 **906-55-24**
Lyndon B. Johnson Space Center, Houston, Tex.
FLIGHT EXPERIMENT DEFINITION USING INSTRUMENTED RMS AS LARGE STRUCTURE TO INVESTIGATE DYNAMICS
H. Kaupp 713-525-2094

The fidelity of existing digital programs and techniques for designing control systems for flexible bodies is uncertain because of the complexity of the dynamics involved and due to the inability to obtain comprehensive test data under I g conditions. The orbiter with its RMS (remote manipulator system) deployed and in operation is a flexible structure with a number of integral sensors. A carefully selected set of arm maneuvers and the resulting sensed data will be used to: evaluate the fidelity of the RMS dynamic models and thereby verify the modeling process; to extrapolate this modeling experience to other flexible structure control applications; and possibly, to improve the RMS control system.

W80-70775 **906-55-25**
Lyndon B. Johnson Space Center, Houston, Tex.
LARGE SPACE STRUCTURES TENSION TIE CABLE
L. J. Leger 713-525-2059

Tension tie cables are important components of large space structures. High dimensional stability requirements of these large structures, thermal expansion characteristics of tension tie cable, will most likely have to be matched to the structure. The objective of this task is to define characteristics of cable materials as well as produce sample cables for evaluation.

W80-70776 **906-60-01**
Marshall Space Flight Center, Huntsville, Ala.
SOLAR ELECTRIC PROPULSION SYSTEM (SEPS) - PHASE B DEFINITION
John H. Harlow 205-872-3322

The objectives are to have industry propose competitive SEPS concepts to meet the mission needs of high energy planetary and Earth orbital missions; to perform preliminary design trades to enhance the definition of the concepts; to provide phase C/D planning information and costs; and to accomplish proof of concept supporting developments to permit high confidence in the concept/prime contractor selected for the development of SEPS (Phase C/D).

W80-70777 **906-61-11**
Lyndon B. Johnson Space Center, Houston, Tex.
FLEXIBLE DEPLOYABLE RADIATOR
W. E. Ellis 713-525-4941

The orbiter's heat rejection is essentially fixed during the operational phase, and the experiments will generally utilize common experiment containers (i.e., spacelab). Therefore, accommodation of all but nominal heat rejection requirements will be difficult. To circumvent this problem and provide an available heat rejection subsystem which can be easily integrated into the orbiter to increase the heat rejection, a flexible/deployable radiator subsystem should be and is now being pursued. This system concept permits the packaging of the radiator into a compact unit which can be stowed in the payload bay during launch. Onorbit after the opening of the cargo bay doors and exposing the payload, the radiator can be deployed to provide additional orbiter heat rejection. The concept can also be used to provide cooling to free-flying payloads launched by the orbiter. The concept permits the independent development and qualification of a heat rejection system which can support a wide variety of orbiter missions and be available for any experiment user without requiring structural and systems accommodation of a new conventional radiator system.

W80-70778 **906-63-13**
Marshall Space Flight Center, Huntsville, Ala.
CRYOGENIC COMPONENT INTERFACE TESTING
L. J. Hastings 205-872-3625

The objective is to design, assemble, and ground test a flight-weight, low cost, reusable system for orbital storage and zero-G conditioning/outflow of subcritical cryogens.

W80-70779 **906-63-15**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED TRANSPORTATION SYSTEMS ANALYSIS
B. W. Shelton 205-872-3939

The objective is to develop a data base and simplified design analysis techniques for sizing, preliminary design definition, quick response design sensitivity analyses, and design/configuration interactions for advanced transportation systems - including both advanced launch vehicles and orbit transfer vehicles.

W80-70780 **906-64-11**
John F. Kennedy Space Center, Cocoa Beach, Fla.
FIBER OPTICS COMMUNICATIONS
A. Jorolan 305-823-3086

KSC is committed to a requirement which will provide an operational broad band communication link in support of Spacelab checkout. The link must be capable of transmitting 50 Megabit Per Second (MBS) signals between the Orbiter Processing Facility (OPF) the communication and tracking (C&T) station and the Operation and Checkout (O&C) building Spacelab test stands located 11.5 km apart in one instance. A tradeoff of conditions and capabilities resulted in the selection of a multimode fiber optic link. However, the need for repeaters adds to the system complexity in a multimode fiber optic link. To eliminate the need for repeaters in future KSC fiber optics communication links, KSC is considering using single mode fibers. Single mode fibers are not subject to the same limitations as multimode fibers. However, the single mode fiber approach has not, however, been tested nor installed under actual field conditions by industry. A single mode installation is also needed as a test bed for the emerging integrated optical component R&D program, which includes the Multiwave Monolithic Integrated Fiber Optic Terminal (MMIFOT) and optical switch RTOPs sponsored by JSC and GSFC respectively.

W80-70781 **906-64-13**
John F. Kennedy Space Center, Cocoa Beach, Fla.
INSTALLATION & REPAIR OF ADVANCED THERMAL PROTECTION SYSTEMS
F. Jones 305-823-2713
(910-21-12)

The primary objective of this effort is to provide the shuttle orbiter with an effective thermal protection system for flight. Repair techniques are required for multiple use of the protection material. Technology developed under this RTOP will significantly impact the established baseline and reduce orbiter refurbishment costs and time. A task under the RTOP developed an improved flexible reusable surface insulation (FRSI) that is easier to install and repair. This FRSI gave a higher temperature range than the basic baseline FRSI. A task under this RTOP will be to develop the necessary techniques for in-place repair of the advanced flexible reusable insulation (AFRSI).

W80-70782 **906-64-14**
John F. Kennedy Space Center, Cocoa Beach, Fla.
METEOROLOGICAL INFORMATION SYSTEMS -- LIGHTNING RESEARCH
W. Jafferis 305-823-2366

The objective of this effort is the improvement of meteorological forecasting and data gathering, transmission, and analyses at the Kennedy Space Center (KSC).

W80-70783 **906-64-15**
John F. Kennedy Space Center, Cocoa Beach, Fla.
TOXIC WASTE TECHNOLOGY AND CONTROL CONCEPTS
P. D. Toft 305-867-4049
(910-09-01)

The overall objective of this RTOP is to formulate, investigate, and prototype new technology to improve the STS operational baseline at KSC in the handling and disposal of toxic and hazardous wastes.

W80-70784 **906-64-17**
John F. Kennedy Space Center, Cocoa Beach, Fla.
FAST ANALYTICAL DENSITOMETRY STUDY
H. Bennett 305-823-3910

Two of the major techniques used by the Microchemical Analysis Laboratory to identify materials are X-ray diffraction and emission and emission spectrography, both of which require photographic media to record the pattern or spectrum. Implementing this RTOP will eliminate visual reading of X-ray diffraction films, which is necessary for more than 90% of all samples analyzed by diffraction, and reduce the time required for this reading by more than 50%. Somewhat smaller reductions in time are forecast for emission spectrographic plates. The work proposed under this RTOP will increase the usefulness of work performed in earlier studies by supplying a missing link between the raw data and the identification/quantification of materials analyzed in this laboratory.

W80-70785 **906-64-18**
John F. Kennedy Space Center, Cocoa Beach, Fla.
AIRBORNE ELECTRIC FIELD MEASUREMENT CAPABILITY
W. H. Brown 305-823-2780

Atmospheric electric field research has been conducted extensively by Kennedy Space Center to identify hazards to personnel and equipment during launch operations. Extensive research has been conducted and documented on the relationship of electric fields from ground to 10,000 ft and related hazards from lightning. A major impediment to assessing hazards from high altitude electrified clouds is the lack of instrumentation which can be used on high performance aircraft that can reach high altitudes during storm development.

W80-70786 **906-70-01**
Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE/TETHERED SATELLITE SYSTEM (TSS) (PHASE B EXTENSION STUDIES)
J. H. Laue 205-872-0163

The objective of the FY-80 work will be to complete the phase B extension study tasks initiated with Ball and Martin in FY-79.

W80-70787 **906-71-17**
Lyndon B. Johnson Space Center, Houston, Tex.
DEVELOPMENT OF AUTOMATED RENDEZVOUS AND PROXIMITY OPERATIONS TECHNIQUES
R. W. Becker 713-525-5276

The prime objective of this effort is to develop a flight profile(s) and recommend hardware/software requirements that will provide a totally automated rendezvous, stationkeeping, and docking capability. The study will also investigate enhancements of the space shuttle orbiter to automatically rendezvous and stationkeep with payloads. Inherent in this vehicle would be a capability to refurbish or retrieve a payload.

W80-70788 **906-75-11**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED MANIPULATOR ARM AND END EFFECTOR DEVELOPMENT
J. L. Burch 205-872-3442

The objective is to develop mechanical integrity, control precision, sensory feedback and computer programming required for performing work in space. Three distinct classes of arms are currently being developed: (1) manual (stick) or slave (exoskeletal) control, (2) automated control (for repeated tasks), and (3) hierarchical control (for task assignments requiring basic machine intelligence).

W80-70789 **906-75-13**
Marshall Space Flight Center, Huntsville, Ala.
LONG RANGE VIDEO SYSTEMS
Glenn D. Craig 205-872-1574

The objectives of the FY-80 effort will be a preliminary study of the aspects of bandwidth reduction techniques for applicability to long range teleoperator video communications.

W80-70790 **906-75-17**
Marshall Space Flight Center, Huntsville, Ala.
DOCKING PROBE CONCEPTS
E. Guerin 205-872-4271

The objectives are to develop and evaluate capture/docking mechanism concepts utilizing the MSFC 5 DOF and 6 DOF motion simulators, and establish representative masses, inertias, solar illumination, visual and on-board lighting requirements and output parametric data for flight hardware requirements.

W80-70791 **906-75-18**
Marshall Space Flight Center, Huntsville, Ala.
SYSTEMS SIMULATION FOR GENERIC TRS
Frank L. Vinz 205-872-4129

TRS docking mechanism, control system, TV, range and other sensor requirements will be analyzed and eventually specified by a total system simulation approach that will include interdependence of control system performance, vehicle and payload mass properties, representative flight CRT displays, docking mechanism tolerance for vehicle misalignments, relative rates between vehicles, and man-in-the-loop considerations.

W80-70792 **906-75-19**
Marshall Space Flight Center, Huntsville, Ala.
RENDEZVOUS/DOCKING RADAR
D. Stone 205-872-4629

The objective is the determination of radar system characteristics to meet the requirements of TRS and evaluation of existing radar systems to determine specific new technology that will be required for rendezvous and docking purposes.

W80-70793 **906-75-20**
Marshall Space Flight Center, Huntsville, Ala.
DOCKING DYNAMICS AND CONTROL SYSTEM ANALYSIS FOR GENERIC TRS
Harry J. Buchanan 205-872-4582

The objective is to provide design requirements for candidate probe mechanisms, including misalignment envelope for capture, docking loads, and interface moment capability when docked. Other system requirements impinging indirectly upon the mechanism would also be addressed. These would include range and range rate requirements, video system requirements, docking target concept evaluation, TRS handling qualities, thruster sizing, etc. Final phase would be a concept verification of the TRS including prototype mechanisms in a 6 DOF simulation facility.

W80-70794 **906-75-21**
Lyndon B. Johnson Space Center, Houston, Tex.
MANNED REMOTE WORK STATION
Samuel H. Nassiff 713-525-2478

The objectives are to perform a phased development of a manned remote work station development test article (DTA); integrate, checkout, and operate the DTA in the JSC simulation facility; and perform engineering evaluations and simulations in the manipulator development facility.

W80-70795 **906-75-22**
Lyndon B. Johnson Space Center, Houston, Tex.
SATELLITE POPULATION ASSESSMENT
D. J. Kessler 713-525-2956

The objectives of this task are to determine the restrictions which may be necessary to future spacecraft in order to reduce, avoid, or protect against the projected debris hazard in earth orbit. Activities will include modeling projected traffic models, satellite fragmentation rates, and analyses to improve the completeness of currently available data.

W80-70796 **906-75-23**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED RENDEZVOUS TRACKING SENSOR
J. C. Lamoreux 713-525-5561

The objectives are to investigate key technology areas for a versatile, high performance, modular sensor; develop candidate conceptual designs using high frequency microwaves or lasers; and breadboard recommended approaches for evaluation. Requirements will be optimized through parametric analyses and tradeoffs of technology capabilities, weight, size, vehicle/propulsion capabilities, proximity operations considerations and overall costs. Concepts for a family of mix-and-match modules to satisfy various rendezvous sensing requirements will be investigated.

W80-70797 **906-75-24**
Lyndon B. Johnson Space Center, Houston, Tex.
DEVELOPMENT OF EVA COMMUNICATIONS SYSTEMS FOR SATELLITE SERVICES OPERATIONS
P. E. Shack 713-525-4926

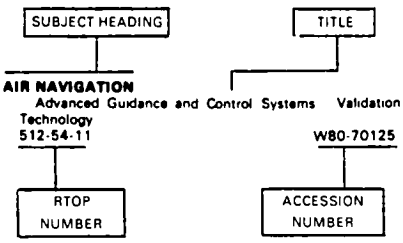
This RTOP will provide a proven design of an EVA communications system to be used for satellite servicing operations. The system will provide multiple communications links and remote controls for EVA crewmen involved in satellite servicing whether in tethered EMU's, MMU's, RMS-attached work stations, or free flyers. It will include command and telemetry capability to allow the system to be tailored to mission requirements.

W80-70798 **906-90-06**
Marshall Space Flight Center, Huntsville, Ala.
SCIENCE AND APPLICATIONS PLATFORM STUDY
M. E. Nein 205-453-3430

The objective will be to identify a space platform system program which can effectively provide for the requirements of the user community. This involves: (1) analysis of payload accommodations, (2) identification of design drivers, (3) subsystem trade studies, and (4) costing analysis to develop program sensitivities and overall cost estimates.

RTOP Summary

Typical Subject Index Listing



A title is used to provide a more exact description of the subject matter. The RTOP accession number is used to locate the bibliographic citations and technical summaries in the Summary Section.

A

B

C

D

E

F

G

H

I

J

K

L

M

N

P

Q

R

S

T

U

V

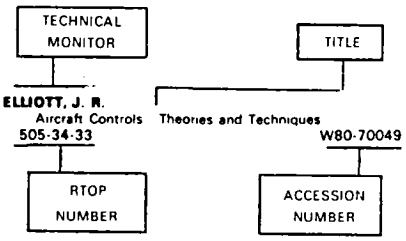
W

X

Y

RTOP Summary

Typical Monitor Index Listing



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G

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I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

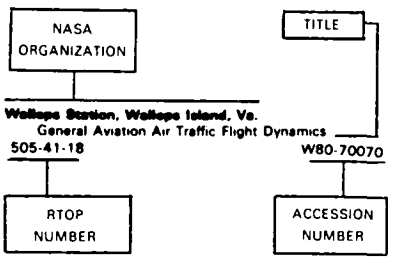
Z

RESPONSIBLE NASA ORGANIZATION INDEX

FISCAL YEAR 1980

RTOP Summary

Typical Responsible NASA Organization Index Listing



Listings in this index are arranged alphabetically by Responsible NASA Organization. The title of the RTOP provides the user with a brief description of the subject matter. The accession number denotes the number by which the citation and the technical summary can be located within the Summary Section. The titles are arranged under each Responsible NASA Organization in ascending accession number order.

A

Ames Research Center, Moffett Field, Calif.

Computational Methods and Applications in Fluid Dynamics
505-31-11 W80-70001

Turbulence and Modeling
505-31-21 W80-70003

Airfoil and Wing Development
505-31-31 W80-70005

Aerodynamic Theory/Experimental Integration
505-31-41 W80-70007

Aerodynamic Test Methods and Instrumentation
505-31-51 W80-70010

Noise Reduction Technology for Short-Haul Aircraft
505-32-01 W80-70017

Fatigue Damage and Environmental Effects in Metals & Composites
505-33-21 W80-70033

Fire Resistant Materials
505-33-31 W80-70035

Navigation and Guidance: Short Range Operations
505-34-11 W80-70044

Aircraft Controls: Reliability & Enhancement
505-34-31 W80-70047

Flight Management Systems
505-35-21 W80-70054

Simulation Technology for Aeronautics
505-35-31 W80-70057

Fund for Independent Research (Aeronautics)
505-36-11 W80-70059

Aeronautics Graduate Research Program - FY 1980
505-36-21 W80-70063

General Aviation Aerodynamic Performance Technology
505-41-11 W80-70067

Rotorcraft Aeroelasticity and Structural Dynamics
505-42-11 W80-70080

Aerodynamic Performance, Dynamics and Handling Qualities
505-42-21 W80-70082

Integrated Avionic Control System for Rotorcraft
505-42-31 W80-70084

Heavy-Lift/Short-Haul Airship Technology
505-42-51 W80-70085

Advanced VTOL Aircraft Aerodynamics and Flight Dynamics Research
505-42-71 W80-70087

Flight Vehicle Dynamics
505-43-11 W80-70089

High Performance Aircraft Airframe-Propulsion Integration
505-43-21 W80-70092

Interagency and Industrial Assistance and Testing
505-43-31 W80-70095

Aviation Safety Technology (In-Flight Detection and Prediction of Clear-Air-Turbulence and Wind Shear)
505-44-11 W80-70101

Aviation Safety Technology - Operation Problems & Fireworthiness
505-44-21 W80-70108

Aircraft Systems Operational Safety Efficiency Improvement
505-44-31 W80-70115

Advanced Guidance and Control Systems: Validation Technology
512-54-11 W80-70125

Human Factors in Aviation Safety
512-55-11 W80-70127

Advanced Rotorcraft Conceptual and Technology Assessment Studies
530-02-11 W80-70131

Advanced Rotorcraft Systems Studies
530-02-11 W80-70132

General Aviation Advanced Avionics Systems
531-01-11 W80-70137

Helicopter and Advanced Rotorcraft Operating Systems Experiments
532-01-11 W80-70138

Quiet Propulsive-Lift Technology Experiments - Aircraft Performance and Operating Systems Research
532-02-11 W80-70139

Advanced Rotor Systems Technology/RSRA Operations
532-03-11 W80-70141

Tilt Rotor Research Aircraft Flight Investigations
532-04-11 W80-70142

VTOL Systems Technology
532-05-11 W80-70144

Fuel Tank Sealants
533-01-11 W80-70146

Energy Efficient Transport Wind Tunnel Testing
534-02-11 W80-70160

Evaluation and Development of Advanced Structural Composite Materials
534-03-11 W80-70166

FIREMEN - Fire Resistant Materials
534-05-11 W80-70171

Advanced Turboprop - Installation Aerodynamics
535-03-11 W80-70175

Computational and Experimental Aerothermodynamics
506-51-11 W80-70180

Planetary Probe Aerothermodynamic Technology
506-51-21 W80-70182

OEX Flight Data Analysis
506-51-31 W80-70184

Surface Physics and Computational Chemistry
506-53-11 W80-70193

Thermal Protection Systems Materials & Systems Evaluation
506-53-31 W80-70200

Photophysics and Laser Diagnostics
506-54-41 W80-70213

Fund for Independent Research (Space)
506-56-11 W80-70243

Infrared Detectors: Far IR Sensors
506-61-41 W80-70256

Sensor Cooling: Cryogenic Technology for Cooling Detectors Below 10 Kelvin
506-61-81 W80-70269

Space Shuttle: Configurations and Aerothermodynamics
506-63-11 W80-70276

Space System Studies - Information and Spacecraft Systems
540-02-11 W80-70283

Infrared Imagery of Shuttle
543-01-05 W80-70313

OEX Thermal Protection Experiments
543-01-06 W80-70314

Aerosol Climatic Effects Special Study
146-10-04 W80-70340

Theoretical Studies of the Upper Tropospheric Aerosol Layer and of the Sahara Dust
146-20-23 W80-70345

Instrument Systems for Measurement of Trace Gas Constituents in the Stratosphere
147-10-04 W80-70403

Development of New Instrument Systems for Detection of Trace Constituents in the Stratosphere
147-10-06 W80-70404

Airborne Platform Support for Stratospheric Sampling Program
147-10-10 W80-70406

Quantitative Infrared Spectroscopy of Minor Constituents of the Earth's Stratosphere
147-20-03 W80-70410

Molecular Properties of Stratospheric Constituents
147-30-01 W80-70414

Stratospheric Research
147-30-02 W80-70416

Evaluation and Improvement of Change Detection Procedures
677-21-08 W80-70461

Accuracy Assessment of Satellite Derived Land-Use Map
677-21-11 W80-70468

Planetology: Aeolian Processes on Planets
151-01-60 W80-70527

Theoretical Studies of Planetary Bodies
151-02-60 W80-70529

Studies of the Distribution of Elements and Mineral Phases Among Meteorites
152-03-60 W80-70534

Lunar Interior and Magnetosphere
153-04-61 W80-70543

Infrared Features of Planets and Satellites
153-07-60 W80-70550

NASA Ames Research Center Vertical Gun Facility
153-08-60 W80-70552

Planetary Atmospheric Composition and Structure
154-10-80 W80-70556

Dynamics of Planetary Atmospheres
154-20-80 W80-70558

Planetary Clouds, Particulates and Ices
154-30-80 W80-70562

Aeronomy of Planetary Atmospheres: Chemistry
154-75-80 W80-70572

Supporting Research for Atmosphere Structure Measurements by Use of Planetary Entry Probes
154-90-80 W80-70577

Magnetospheric Physics - Particles and Particle/Field Interaction
170-36-55 W80-70588

Life Support Requirements for CELSS
174-03-02 W80-70601

Waste Management for CELSS
174-05-02 W80-70602

Systems Management, Control, and Ecological Considerations for CELSS
174-07-02 W80-70603

Theoretical Astrophysics
188-41-55 W80-70613

Chemical Evolution
192-55-61 W80-70634

Bioinstrumentation
192-55-65 W80-70635

Planetary Environments - Organic Chemistry
192-55-66 W80-70636

Origin and Evolution of Life
192-55-67 W80-70637

Biological and Biochemical Aspects of Ecosystems
192-55-69 W80-70638

Detection of Other Planetary Systems
196-21-68 W80-70639

Planetary Astronomy and Supporting Laboratory Research
196-41-67 W80-70646

Cardiovascular Deconditioning
199-01-01 W80-70658

Bone/Muscle Alterations
199-07-01 W80-70661

Preflight Detection of Disease
199-11-01 W80-70663

Human Behavior and Performance
199-17-02 W80-70666

Supporting Biomedical Research
199-21-02 W80-70668

Advanced Extravehicular Systems
199-71-01 W80-70677

Advanced Life Support Systems
199-73-01 W80-70678

Joint US/USSR Biological Satellite Project (Cosmos 79 and 81)
199-91-02 W80-70679

Interdisciplinary Research
199-97-02 W80-70681

Development of Spacelab Payloads for Infrared Astronomy (SPIRA)
358-41-06 W80-70684

Pioneer 6-11 Plasma Data Analysis
385-36-01 W80-70690

D

Hugh L. Dryden Flight Research Center, Edwards, Calif.

Aeronautics Flight Experiments
505-31-44 W80-70009

Flight Research Instrumentation Development
505-31-54 W80-70012

Propulsion Integrated Control Technology
505-32-64 W80-70027

Flight Loads and Aeroelasticity
505-33-54 W80-70040

G

J

J

K

L

M

N

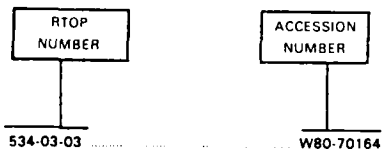
W

RTOP NUMBER INDEX

FISCAL YEAR 1980

RTOP Summary

Typical RTOP Number Index Listing



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